The Journal
OF THE
Royal United Service Institution.

VOL. XVII. 1873. No. LXXIV.

REPORT OF A RECONNAISSANCE OF THE NORTH-WEST PROVINCES AND INDIAN TERRITORIES OF THE DOMINION OF CANADA, AND NARRATIVE OF JOURNEY ACROSS THE CONTINENT THROUGH CANADIAN TERRITORY TO BRITISH COLUMBIA AND VANCOUVER ISLAND.

Communicated by Colonel ROBERTSON-ROSS, Commanding the Militia of Canada and Adjutant-General of Militia in 1872.

CHAPTER I.

ON the termination of the annual training of the Militia in the Provinces of Ontario and Quebec, I proceeded from Ottawa in the first instance, *viâ* Lake Superior and the "Dawson Route" to Manitoba, and in accordance with instructions, subsequently crossed the Continent through Canadian territory to the Pacific Coast and Vancouver Island, travelling nearly the whole distance from Fort Garry on horseback.

Leaving Collingwood on the 16th July, in the steamboat for Thunder Bay (Lake Superior), the vessel reached her destination early in the morning of the 22nd, stopping *en route* at the settlements of Owen Sound, Leith, and Killarney, on the shores of Lake Huron, and at Gargantua Bay, Michipicoton Island, and Neepigon, on Lake Superior. Neepigon Bay is a good and safe harbour, and the place itself is probably destined to be of great importance in connection with the Canadian Pacific Railway. On arrival at Prince Arthur's Landing, I found that a considerable and apparently thriving settlement had already sprung up at that place. The population now numbers about 500; many good houses have been erected, and municipal government has been established. Thunder Bay is one of the best and safest harbours on the north shore of Lake Superior, and the surrounding scenery is very beautiful. For want of a proper wharf, considerable inconvenience is experienced, but as the one now in course of construction will be completed shortly, the landing facilities will then be greatly improved and be all that is likely to be required for some time to come Owing to the great mineral resources and the valuable silver and copper mines which exist in this neighbourhood, and from the excellence of its harbour, it may reasonably be expected, that a wealthy and important settlement will ere long be established at Thunder Bay.

From Prince Arthur's Landing I proceeded on the 22nd July, by waggon in one day, to Lake Shebandowan, a distance of about 45 miles, by what may now be fairly considered a good road. All the

streams have been bridged, and a very substantial structure is erected across the Matawan. When this road shall have been gravelled throughout its entire length, which will probably be effected this summer, it will be as good a one as can be desired. The country through which the road passes from Lake Superior to Shebandowan is well wooded and much better suited for settlement than is generally supposed. Although the soil in the immediate neighbourhood of Prince Arthur's Landing is somewhat sandy, the greater part of the country passed through is perfectly well suited for farming and agriculture. At the Matawan River, farming operations had commenced; very fine timothy hay had already been raised at that place, and the growth of the vegetables and cereals which had been but a short time before planted gave excellent promise.

From Lake Shebandowan I proceeded by canoe to the north-west angle of the Lake of the Woods in seven days, a distance of 310 miles, through the chain of inland waters known as the "Dawson Route," towed part of the way by tug steamers. Considerable progress has been made in opening up and improving this line of communication through the dominion to the vast and important territories of the north-west, and I am satisfied that if greater means could have been placed at the disposal of Mr. S. J. Dawson, much greater progress towards completing the work would have been made by that able engineer. The portages have been greatly improved. There were horses or bullocks with carts or waggons on nearly all. In many instances a shorter and better route than that originally followed, has been adopted, and altogether it is now not only a perfectly available and valuable line of communication during the open season, but it is an indispensable work towards the settlement of the country through which it passes.

At Fort Francis two steamboats of considerable size are being built; one has already been launched, and both are expected to be finished early next spring. One of these steamboats is intended for Rainy River and the Lake of the Woods, the other for Rainy Lake. Additional tug-steamers are also to be obtained, so that by next summer it is expected there will be steam power on all the waters. When this is carried out, the journey from Lake Superior to Manitoba through Dominion Territory will be made comfortably in four or five days, and the transport of passengers, freight, waggons, and horses by the "Dawson Route," effected without difficulty.

For the passage of troops, during the summer season, there is now no difficulty. In October last a detachment of 215 soldiers with two light field guns were conveyed in 25 days from Collingwood, in Ontario, to Fort Garry, in the Province of Manitoba; and by next summer I consider there would probably be no great difficulty in conveying, if required, both cavalry and artillery, as well as infantry, in considerable numbers by the "Dawson Route."

The country along the banks of Rainy Lake and Rainy River is well wooded with valuable timber, extremely picturesque, and still better suited for settlement than the country between Lakes Superior and Shebandowan. The lakes and rivers teem with fish, and self-

sustaining settlements could be readily established there with advantage. From most careful enquiries it appears that the number of Indians occupying the country along the line of the "Dawson Route," and who belong to the Ojibbeway tribe, does not exceed a total population of 4,000, of whom it is believed about 800 are men capable of bearing arms. Although among these Indians there may be some restless characters, they are considered good Indians on the whole, and if kindly but firmly treated, they are not likely to cause any interruption along this route, or offer opposition to the peaceful settlement of the country.

During the past summer, the Ojibbéway tribe were apprehensive of an attack from the Sioux, their hereditary enemies, dwelling west of the Red River, on the American side of the international boundary line. With a view therefore of preserving the peace of the country, supporting our Indian Commissioner when engaged in making treaties, and for the protection of settlers, I am of opinion that it would be advisable to encamp a detachment of about 100 soldiers during the summer months at Fort Francis. This force could be taken from the Militia now on duty at Fort Garry, returning to that station for the winter months. To send an Indian Commissioner unaccompanied by a military force to make a treaty with this tribe last summer proved a failure. I would further suggest that the *employés* of the Department of Public Works stationed along the line of the "Dawson Route," who will this summer number about 400 men, should be organized into a naval brigade, to be armed and equipped by the Militia Department, and that the offer to raise two volunteer companies of Militia at Prince Arthur's Landing, Thunder Bay, be accepted. The existence of such a material power along the line would, I feel sure, prove of the greatest importance. There is no doubt that the passage of troops for the last three years proceeding to and from Fort Garry in support of the civil power, on missions of peace, has already been attended with the best results.

From the north-west angle of the Lake of the Woods I drove to Fort Garry, in Manitoba, in a waggon with two horses, a distance of 95 miles in a day and a half, the journey from Prince Arthur's Landing thus occupying nine and a half days. The road from the Lake of the Woods to Oak Point, where the prairie commences, is now as good a one as can be found in almost any country part of the provinces of Ontario and Quebec; and from the north-west angle of the Lake of the Woods the ordinary carts and waggons of the country, and almost any kind of light carriage or vehicle, can be driven without difficulty during the summer season, for 1,300 or 1,400 miles across the great prairies of the north-west, through one of the most fertile and beautiful countries in the world, to the Rocky Mountains.

Chapter II.

Inspections in Manitoba.

Arriving at Upper Fort Garry on the 31st July, I inspected the military force on duty there the following day, and the detachments

stationed at the Lower Fort and in the Hudson's Bay Company's post near Pembina, subsequently.

The military force authorised at present to be maintained on duty in Manitoba consists of three hundred infantry formed into a provisional four company battalion under the command of a Major, and an artillery detachment of one Officer and 25 gunners; but at the time of my inspection, the force was considerably below its strength, and divided as follows:—

At Upper Fort Garry.....	181	(all ranks)
At Lower „	20	„
At the Hudson's Bay Company's post near Pembina	42	„
Total.....	243	„

The decrease in the strength authorised which then existed, resulted from the discharge of time-expired men, but a considerable detachment was despatched to Fort Garry from the provinces of Ontario and Quebec in October last, to complete the authorised strength.

I am happy to report that on inspecting the infantry battalion, I found it to be in as satisfactory a condition with regard to drill and discipline, as could reasonably be expected, considering the very short periods allowed for the enlistment of the men, and the Officers' uncertain tenure of office. The companies stationed at Upper Fort Garry were encamped at the time of inspection on the banks of the Assiniboine, about one mile from its junction with the Red River; the cleanliness, neatness, and good order of this camp, which was occupied during the whole summer, reflected much credit on Major and Brevet-Lieutenant-Colonel Irvine, the Officer commanding the battalion. On inspecting the detachment at Pembina I found that there was insufficient accommodation in the small trading post of the Hudson's Bay Company at that place for the number of men there stationed. In view of this fact therefore, and the desirability at the time of strengthening the force at Upper Fort Garry, with the entire concurrence of the Lieut.-Governor of the province, I directed the strength of the detachment at Pembina to be reduced to 1 sergeant, 1 corporal, and 12 men; and there being no necessity for keeping any detachment at Lower Fort Garry, with the concurrence of the Lieut.-Governor, I directed the return of the party there stationed, to the Upper Fort. The battalion is now concentrated in the Upper Fort, and as the majority of the men have been recently enlisted to serve for a period of three years, it may be expected that before long the corps will attain to a higher degree of military discipline and training. The respectability of character and good conduct as men exhibited by the majority of the individuals composing the corps during the last twelve months, has been conspicuous. The soldier-like bearing and discipline displayed by the battalion on a recent occasion when called out in aid of the civil power to quell a riot at the time of the elections, proved it to be a corps upon which the Government and the country can rely. The artillery detachment was sent to Fort Garry subsequent to my inspection. With

regard to the barrack accommodation provided for the battalion in the Hudson's Bay Company's trading post, known as the Upper Fort Garry, I found it to be very inadequate, unsuitable, and generally unfit for permanent military occupation. The store buildings used as barracks for the men required a considerable amount of repair to make them fit for occupation in winter. They consist of wooden sheds, some of them mere shells. The building used as the Officers' quarters, which originally was an excellent one, is now very old and decayed. A very considerable amount of repair is required in it—the roof should be entirely new shingled, though it is a matter of doubt whether the building will stand such repairs. The storage room required for military stores is very inadequate and unfit for keeping such stores with safety; and they are in eight different buildings, one good store-house being all that is required. The armoury in which the spare rifles and arms are kept, is very damp. A powder magazine is required; the Hudson's Bay Company's magazine is generally well filled with their own powder, and is, moreover, very damp. While making this report on the state of the barrack accommodation at Fort Garry, it is but due to the Hon. the Hudson's Bay Company, to state that every assistance and facility in providing for the want of the troops has been afforded by the gentlemen belonging to that great trading Company, as far as circumstances and their own requirements would admit. In very many instances they have placed themselves and their *employés* at no inconsiderable personal inconvenience, in order to accommodate the troops, meet the wishes of Government, and the emergencies of the case.

For the last three years, it has been found necessary to maintain a military force in Fort Garry where only temporary accommodation, as a sort of makeshift, can be provided. The men suffer much during the severe weather in winter from want of proper shelter and accommodation, it is difficult moreover to maintain good order and discipline among a body of soldiers when mixed up with civil *employés* in a Hudson's Bay trading post, and the arrangement altogether, except as a temporary measure, is very inconvenient and unsatisfactory. Under these circumstances, provided it be in harmony with the policy of Government, I would respectfully urge that no further time be lost in taking the necessary steps to supply the military force required, with proper barrack accommodation. On enquiring of the men if they had any complaints to submit relative to their pay, rations, &c., and general treatment, in accordance with my duty, they expressed themselves as perfectly satisfied with their rates of pay, scale of rations, and treatment by their Officers, but invariably in the most respectful manner complained of the wretched barrack accommodation. I feel bound to say that their complaints on this head were just, and to state that it would be only fair to meet the reasonable wants of the men on this point. At no great expense, and with very little trouble, suitable log huts can be erected on advantageous ground, and the greater portion of the work carried out by the men themselves. This arrangement would, I believe, eventually be found the most economical one for the country, if it be the intention to keep a military force in Manitoba,

and it certainly is a very essential one for maintaining the efficiency and welfare of troops. Already the amount of money spent on repairing old buildings and constructing new ones in the Hudson's Bay Company's post would have sufficed to defray the cost of providing proper barrack accommodation in log huts for the force stationed at Fort Garry. I would further urge, if it be the intention of Government to retain any military force on duty in Manitoba, that one hundred men of the provisional battalion be supplied with horses and equipped as mounted riflemen; that an addition of 1 officer and 25 gunners from the School of Gunnery at Kingston be made to the artillery detachment, and the artillery supplied with four of the Horse Artillery guns recently obtained from England. Thus the force would form a small but effective field brigade, and its military power be greatly increased.

With regard to the necessity for maintaining any military force at Fort Garry, no doubt whatever exists in my mind as to the propriety of doing so, in view of the presence of many bands of Indians, considering the primitive state of society in the province, the strong political party-feeling which exists, and the fact that on both sides of the international boundary line, restless and reckless characters among both white men and Indians abound. It is undoubtedly very desirable to maintain a certain number of police constables in the province under the civil power, some of whom should be mounted, but I feel satisfied that the great security for the preservation of good order and the peace of the north-west territories, under the changing state of affairs, will for some years be found to lie in the existence and presence of a disciplined military body, under its own military rules, in addition to, but distinct from, any civil force which it may be thought proper to establish. Whatever feeling may be entertained towards policemen, animosity is rarely, if ever, felt towards disciplined soldiers wearing Her Majesty's uniform, in any portion of the British Empire. In the event of serious disturbance, a police force acting alone, and unsupported by a disciplined military body, would probably be overpowered in a province of mixed races, where every man is armed, while to maintain a military without any civil force is not desirable. I believe that a small number of constables will be sufficient to maintain order in the province, provided the military force is maintained; but that, in the event of serious disturbance, a large police force would be unable to do so, should the military be withdrawn, and I consider the presence of a military force in the north-west territories for some years to come as indispensable in the interests of peace and settlement.

During my inspection in the north-west, I ascertained that some prejudice existed amongst the Indians against the colour of the uniform worn by the men of the provisional battalion. Many of them had said, "Who are those soldiers at Red River wearing dark clothes? Our "old brothers who formerly lived there"—meaning Her Majesty's 6th regiment—"wore red coats," adding, "we know that the soldiers of "our great mother wear red coats, and are our friends." With the view, therefore, of reassuring the Indian mind, and for other reasons, I recommended a change of uniform; this has been carried out; the

Militia on duty at Manitoba now wear red coats, and the matter, apparently small in itself, will probably prove of great value and importance hereafter.

On the 8th of August I inspected the Winnipeg Field Battery, a militia artillery corps, recently organized, and composed of citizens resident in the town of Winnipeg. This battery is under the command of Major Kennedy, a very zealous Officer, but it has not as yet been armed. On the occasion of inspection, the corps took part in a field day, brigaded with the provisional battalion. The battery was armed for the day with some light field guns belonging to the Hudson's Bay Company, kindly placed at their disposal by the Hon. Donald Smith, M.P., chief factor. As soon as circumstances will admit, it is recommended that this battery should be armed with four of the horse artillery field guns recently obtained from England, and supplied with the necessary harness and artillery stores.

The Militia in the province of Manitoba is under the command of Lieutenant-Colonel Osborne Smith, C.M.G., Deputy Adjutant-General, who reports that in the month of May, 126 men of the provisional battalion will probably obtain their discharge on completion of service. That number of men should, therefore, be sent to Fort Garry by the Dawson route so soon as the navigation opens, to maintain the force at its authorised strength; and one Officer and twenty-five gunners should be despatched in addition, to render the artillery detachment more effective.

Chapter III.

From Fort Garry to the Rocky Mountain House.

Having concluded the inspection of the Militia in Manitoba, accompanied by my son, a youth sixteen years of age, as travelling companion, I left Fort Garry on the 10th of August for the Rocky Mountains and British Columbia, with one guide only, and an Indian lad of the Salteux tribe, to cross the continent through Dominion territory to the Pacific coast. The Hudson's Bay Company provided ten horses, two Red River carts, and a suitable equipment for the party, and undertook to supply any guides, horses, and provisions required *en route*, from the different posts in the Swan River and Saskatchewan districts as far as Fort Edmonton or the Rocky Mountain House; but beyond these posts they could not guarantee further progress, nor a safe passage through the country of the Blackfeet Indians, should circumstances require the adoption of that route. Every possible assistance, however, was afforded me by the Hon. Donald Smith, M.P., and the gentlemen connected with the Company at the various posts visited, and my best thanks are due to them, not only for many acts of kindness and hospitality, but for much valuable information respecting the Indian tribes.

At the time of departure from Fort Garry, some doubt was expressed as to the propriety of so small a party travelling without a guard through the Indian territory, and especially through the country of the

Blackfeet tribe, if found necessary to do so; and I have to thank the Government very much for the authority conveyed by your telegram to Fort Garry, to take with me, if desired, a personal escort of six soldiers from the battalion on duty in Manitoba. On full consideration, however, and with the advice of those best able to judge, I did not think it advisable to do so. A military escort of only six men would be inadequate to afford protection in case of any real danger from the Prairie Indians, and might possibly invite attack. Considerable additional expense, moreover, would have been entailed for their transport and subsistence.

Proceeding from Fort Garry through the Swan River and Saskatchewan districts, *viâ* the Hudson's Bay Company's posts of Forts Ellice, Carlton, Pitt, Victoria, and Edmonton, I arrived at the Rocky Mountain House—about 1,200 miles distant from Fort Garry—in 31 days, of which 25 days only were occupied in actual travel. The prairie road or cart trail, extending the whole way from Fort Garry to the Rocky Mountain House, and which has been used for many years by the Hudson's Bay Company, was at that season of the year in excellent order. Many of the streams have been roughly bridged by the Hudson's Bay Company's servants; and except at the crossing of the South Saskatchewan River, where we lost a whole day from the necessity of swimming our horses across, and repairing a damaged scow on which to convey over the carts and baggage, we met with very little difficulty or trouble at any time. For great distances the road led over prairie ground almost as level as a race course. It would be desirable to bridge the Little Saskatchewan River, Birdtail Creek, and Snake Creek, between Fort Garry and Fort Ellice, and to improve the descent to and ascent from the Assiniboine River at Fort Ellice, as owing to the steepness of the road it is somewhat difficult to pass at this point during rainy weather with loaded carts. In addition to this, some repairs and improvements are desirable on the road between Forts Pitt, Victoria, and Edmonton, and across one or two swamps near the Rocky Mountain House; but on the whole a very trifling amount of labour is all that is at present required.

On the journey from Fort Carlton to Edmonton, a distance of between 300 and 400 miles, we were accompanied by the wife of our guide (an *employé* of the Hudson's Bay Company), who with her three young children travelled in a light four-wheeled canvas-covered waggon, driving the vehicle herself nearly the whole way.

It was my intention to overtake at Edmonton, if possible, Mr. Fleming, Chief Engineer of the Pacific Railway, who had started from Fort Garry ten days before me for British Columbia, and in company with him cross the Rocky Mountains by the "Tête Jaune Pass;" on arrival at Edmonton, however, I found that he had quitted that point seven days previously. As no guides could be obtained at Edmonton either for the Tête Jaune or any other pass, it was necessary to proceed to the Rocky Mountain House, a trading post for the Blackfeet Indians, distant about 180 miles south-west from Edmonton, in sight of, and about forty-five miles distant from, the first range of the Rocky Mountains.

Between Fort Garry and Fort Ellice, a distance of 230 miles, the country is diversified and undulating, generally speaking very good and fertile. In some parts alkali lakes are occasionally met with. The open expanses of prairie are relieved with numerous clumps or patches of wood, termed "bluffs." There is plenty of wood suitable for fuel, or for sheltering stock. The wood consists of spruce, willows, birch, and poplar, and in the valley of the Assiniboine there is a good deal of oak. The land in the lower part of the valley of the Assiniboine, for nearly one hundred miles before its junction with the Red River, is of great richness and fertility. Between the western boundary of the province of Manitoba and Fort Ellice, the country in the vicinity of Pine Creek, the Little Saskatchewan River, Shoal Lake, Birdtail Creek, and Snake Creek, is well suited for settlement and farming purposes, more particularly for the raising of stock; but I do not think the soil, generally speaking, so well suited for wheat crops as along the lower parts of the valley of the Assiniboine and Red River. Fort Ellice is situated a short distance from the junction of the Qu'appelle with the Assiniboine River, on the right bank of the latter stream. It is well placed in a military point of view, being built on a plateau at the top of a high, steep, and thickly wooded bank, about two hundred feet above the river. The river is here about sixty yards in breadth and about fifteen feet in depth. The banks are thickly wooded. The Hudson's Bay Company have erected a bridge across the river. The valley of the Assiniboine is depressed about 250 feet below the Prairie level, and is about three-quarters of a mile in breadth. The country around the immediate vicinity of Fort Ellice is well wooded and suitable for settlement. The wood consists chiefly of poplar of no great size, and there is some oak. The Fort itself merely consists of some wooden houses, built of poplar, and surrounded by a stockade, but it might easily be made very defensible, and accommodation for fifty soldiers in addition to the present occupants, readily created.

The Assiniboine River is navigable for good-sized boats all the way from Fort Garry to Fort Ellice, and I believe much further. In spring, no great difficulty would probably be experienced in navigating the river with a stern-wheel steamer of light draught the whole way from Fort Garry to Fort Ellice. Between Fort Ellice and Fort Carlton, on the North Saskatchewan, lies a great extent of country—more than three hundred miles. Throughout a considerable portion of the road followed, alkali lakes are prevalent, and for several days I found no good water.

Upon the whole I do not consider the country between Fort Ellice and the Touchwood Hills, which are about midway between Fort Ellice and Carlton, and the country beyond the Touchwood Hills for two or three days' journey towards the north-west, so well adapted for settlement as the province of Manitoba, and the country between it and Fort Ellice. From that part of the country, however, where the "Round Hill" (a conspicuous object about two days' journey south of Fort Carlton) is situated, to North Saskatchewan River, and from thence for several hundreds of miles westward to the Rocky Mountains,

the value and fertility of the country for agricultural and stock-raising purposes has certainly not been exaggerated in the accounts of any travellers.

The North Saskatchewan at Fort Carlton is about four hundred yards in breadth, with a current of between two and three miles; and it nowhere exceeds that breadth upwards to the Rocky Mountains. Although there are numerous sand bars, it is navigable for large-sized boats, and I believe for stern-wheel steamers of light draught from within about twelve miles of Lake Winnipeg nearly to the base of the Rocky Mountains. When the river is low, steamboats probably would not be able to pass at Coal Rapids below Carlton. At the proper season of the year for navigation, however, it is only necessary to make one or two portages the whole way from Fort Garry, on the Red River, to the Rocky Mountain House. The land lying between the north and south branches of the Saskatchewan River, near Carlton, and for many miles to the east and west, is particularly well adapted for settlement, and the whole country along the north bank of the North Saskatchewan, extending for hundreds of miles to the westward, is very fertile and admirably adapted for settlement. There are two half-breed settlements at no great distance from Fort Carlton—one at St. Laure (French half-breed), on the South Saskatchewan, about 30 miles south-west from Fort Carlton; the other, an English half-breed settlement (Prince Albert), 50 miles east from Fort Carlton, on the North Saskatchewan. The population of St. Laure, last year, was 68 men, 58 women, and 198 children, possessing 577 horses; that of Prince Albert, 35 men, 57 women, 81 children, and 181 Indians. The population of these two settlements is probably much increased since this census was made, and it is believed that a considerable number of the half-breed population in Manitoba will leave that province next summer and move to these settlements.

The country to the south of the North Saskatchewan, leading towards what are called the Great Plains, I understand is by no means so fertile or so well suited for agriculture; and there is there, I believe, a scarcity of both fuel and water. Some doubts may exist as to the possibility of raising as large wheat crops along the valley of the North Saskatchewan, from the occasional occurrence of summer frosts, as can be raised in the province of Manitoba; but I believe that for stock farming, vegetables and the hardier grains, such as oats, barley, &c., the fertile belt of British North America can hardly be surpassed.

With regard to the temperature of the climate, on very few occasions was there any interruption to its mildness in the past summer during the months of June, July, August, September, and October. On the night of the 17th August, when travelling between Fort Ellice and the Touchwood Hills, I experienced a slight frost, but not sufficient, so far as I could judge, to materially injure wheat crops. Again, on the night of the 10th September, when about two days' journey from the Rocky Mountain House, I experienced another similar frost—these were the only occasions during the past season that I experienced any frosts or cold, until reaching the foot of the Rocky Mountains on the 21st September near the Porcupine Hills, being then at an altitude of

between 3,000 and 4,000 feet above the sea level—and at the time of the Equinox, I was stopped for several days by a snow storm, which not unfrequently occurs in the mountains, but rarely so early on the plains. This snow disappeared from the plains in a few days, almost as rapidly as it came, and with the above exceptions, from the time of quitting the Lake of the Woods, one hundred miles east of Fort Garry, until reaching the Pacific Coast, a period of three months, the climate was delightful—it was frequently quite unnecessary to pitch a tent when camping for the night; for many nights I slept out in the open air, or lay underneath the cart.

It takes twenty days to go with large-sized row boats, carrying cargo, from Carlton to Fort Edmonton, but a light draught steamer would accomplish the distance in a short time. Gold is to be found in the sand bars of the Saskatchewan the whole way from Fort Edmonton to Carlton, and almost throughout its entire length. I was informed that at Carlton a man can earn from two to three dollars daily, during the proper season, by washing the sand of the river,—and at Fort Edmonton, from five to six dollars daily for seven or eight months in the year.

At Fort Edmonton during the past summer there were only five or six men engaged mining, from one of whom I obtained some good specimens of the Saskatchewan gold, which is considered equal in quality to that obtained in the mines of British Columbia. The few miners who have as yet penetrated into the Saskatchewan country state that gold is to be found in nearly all the streams which flow into the Saskatchewan River, and they are of opinion that quite as rich deposits exist on the eastern as on the western side of the Rocky Mountains.

The Hudson's Bay Company's forts along the line of the North Saskatchewan at Carlton, Pitt, Victoria, and Edmonton consist of wooden houses surrounded by stockades; these stockades are about twenty feet high with small bastions at the angles to afford flanking defence—although probably sufficient to afford protection from Indians, they are of slight strength. At Forts Carlton, Pitt, and Victoria, accommodation for companies of soldiers, 50 strong, could be found in these Hudson's Bay Company's forts, in addition to the present occupants, and at Fort Edmonton, for about 125 soldiers. These forts are conveniently enough situated for purposes of trade, but in a military point of view are badly placed, being in nearly every instance commanded from the rear by higher ground. The Rocky Mountain House, however, is built on a good military site, and could easily be put in a defensible condition.

The scenery about the Touchwood Hills, as well as in many other sections of the country lying between Forts Garry and Edmonton, is extremely picturesque and park-like. At the time of the year I passed through, the wild flowers were in full bloom; the prairie covered with beautiful plants and countless roses, both red and white, presented a gorgeous appearance; not unfrequently when camping for the night the traveller literally makes his bed upon roses.

Fort Carlton and its vicinity is a desirable spot for settlement, but the whole country along the north bank of the Saskatchewan to Edmonton

is at least equally so, offering in many places superior advantages from the greater quantity and better quality of the timber.

From Edmonton to the Rocky Mountain House, especially in the neighbourhood of the Battle River and Wolf Plain, the country is still richer and better wooded.

At Fort Victoria, where a small settlement has arisen, and at Fort Edmonton, I saw several fields of excellent wheat being harvested. I have no doubt whatever that when the valley of the North Saskatchewan is opened up and settled, it will be found to be very productive.

That beautiful country lying in the territory of the Blackfeet Indians, extending for about 300 miles along the Eastern base of the Rocky Mountains towards the International boundary line, with a varying breadth of from 60 to 80 miles, is in respect of fertility, of surpassing richness—in regard to scenery, magnificent. The effect produced upon the mind of the traveller who journeys day after day through these vast and beautiful solitudes is of an elevating character; the recollection of the scenes visited, remains deeply impressed upon the memory.

The average temperature during the winter months along the base of the Rocky Mountains in this section of the country, is higher by 15° than that of the western portion of the province of Ontario; all over the Saskatchewan country, horses and cattle winter out. All travellers and old residents in the West, testify to the healthiness of the climate—indeed, in the pure air of the prairie, sickness is almost unknown.

Scattered through the whole of the Saskatchewan country, are numerous lakes generally of no great size; they are the favourite haunts of great numbers of wild duck and geese. Some of the lakes between Forts Carlton and Edmonton, such as Egg Lake, Jack Fish, and Saddle Lake are, however, of considerable size, and contain immense quantities of white fish.

Wild pigeons and prairie hens abound everywhere. In the Touchwood Hills and along the eastern base of the Rocky Mountains, several kinds of deer and bears are very numerous. When travelling through the Touchwood Hills, I killed a bear of the grizzly species, but one of no great size. On the 23rd of September, near the Porcupine Hill, at the base of the Rocky Mountains, I killed another grizzly bear of very large size, the animal weighing about 1,100 lbs. In the country adjacent to the Bow River, and thence southward towards the boundary line, numerous herds of antelope were seen, and some of them were killed by our party. During the past summer, the buffalo were very numerous on the great plains that lie between the North and South Saskatchewan Rivers.

Chapter IV.

From the Rocky Mountain House across the Mountains, viâ "Wild Horse Creek," to Victoria, Vancouver Island.

On arrival at the "Rocky Mountain House," I learned that to cross the mountains into British Columbia by the "Vermilion Pass" with horses was impossible, owing to the immense quantity of fallen timber

caused by a great storm in the mountains last spring. An attempt to cross by this pass had been made by a party of Assiniboine Indians early in the summer, without success. Under these circumstances, it became necessary to undertake a journey of about 300 miles through the country of the Blackfeet Indians, and to cross the mountains by the North Kootanie Pass.

Through the kindness of Mr. R. Hardesty, the gentleman in charge of the Hudson's Bay Company Posts in the Saskatchewan district, I obtained the services of three guides from the Post of the Rocky Mountain House, one of whom was "William Munro," the Hudson's Bay Company's interpreter for the Blackfeet Indians, better known throughout the Saskatchewan country by his Indian name of "Piskaan." This guide is a brave man, and one of the most famous travellers and hunters in the service of the Hudson's Bay Company. In company with him and the two other guides, one of whom was a Rocky Mountain Assiniboine Indian, the other a French half-breed, I started along with my son from the Rocky Mountain House, on the 16th September, to pass through the country of the Blackfeet Indians, and cross the mountains by the Kootanie Pass into British Columbia.

The Blackfeet tribe of Indians have always been much dreaded, and their country carefully avoided by travellers. From information obtained at the Rocky Mountain House, and while travelling, it appears that this tribe, which is the most numerous and warlike one of the Prairie Indians in Dominion Territory, is divided into five distinct bands, or rather clans, each band under its own chief, but all maintaining a close connection. These bands are called and known as follows:—

1st. The Sik-si-ka or Blackfeet proper; this band numbers about 700 men, 1,000 women, 1,100 children, possessing about 3,000 horses and ponies, 400 dogs, and having the following arms:—105 rifles, 260 revolvers, 436 flint guns, 286 bows, 48 spears, 37 war axes.

2nd. The Piegans (subdivided into Northern and Southern Piegans) numbering nearly 800 men, 1,100 women, 1,400 children, possessing about 3,500 horses and ponies, 600 dogs, and the following arms:—213 rifles, 412 revolvers, 320 flint guns, 181 bows, 54 spears, 41 war axes.

3rd. The Ka-na-ans (or Blood Indians), numbering about 600 men, 800 women, 900 children, possessing about 2,500 horses and ponies, 480 dogs, and having the following arms:—141 rifles, 318 revolvers, 202 flint guns, 216 bows, 45 spears, 32 war axes.

4th. The Sar-cis (or Beaver Indians), numbering about 100 men, 130 women, 150 children, possessing about 150 horses, 300 dogs, and having the following arms:—6 rifles, 14 revolvers, 64 flint guns, 26 bows, 4 spears, 7 war axes.

Although the Blackfeet may number altogether about 2,350 men, many of these are old, and some of them mere boys. It is not believed that they could bring into the field more than 1,000, or 1,100 men, if as many. They keep together by bands for mutual protection, in what is termed in military language, standing camps; as many as 100 or 150 tents being pitched together, and their chiefs have con rol over the

young men. Their war parties usually consist of only 50 or 60 men, and when on raiding expeditions against hostile tribes, they can make, with horses, extraordinary marches. With the Blackfeet, as with all the Indians in the Western Prairies, when at war, murder and assassination is considered honourable warfare. There are many fine-looking men among the Blackfeet, Sioux, Plain Crees, and other tribes, and they have a bold and military bearing. Their active wiry figures, and keen glittering eyes, betoken high health and condition, and they can endure great hardships and fatigue; but on the whole, the Indians are not equal, in point of physical strength or appearance, to white men hardened by active exercise and inured to labour. As a rule, the Prairie Indians are bold and skilful horsemen, but they are not very skilful with firearms. The Blackfeet and Plain Crees follow the buffalo, subsisting entirely by the chase; they therefore require a great many horses and dogs for transport and hunting purposes. In the present year, peace having existed for the past two summers between the Crees and Blackfeet, and accompanied as I was by a guide well known, and related to the latter tribe, I did not think there was much danger in travelling through their country. There is always, however, great danger, if mistaken for an American citizen, and on approaching the International line, near the Porcupine Hills, of meeting with hostile bands of the Gros Ventres and Crow Indians, from the territories of Dacotah and Montana, United States, who frequently cross into Dominion Territory on horse-stealing expeditions, and who are not likely, if they fall in with travellers, to make distinctions.

From the Rocky Mountain House, the party being increased to five, we took with us twelve horses, one Red River cart for baggage, and carried twelve days' provisions, intending to take the cart as far as practicable, and then câche it. After leaving the Mountain House, no path or trail could be seen, and we journeyed through the country and over the prairies, led only by the instinct of the guide. After travelling for two days through thick wood country, in a south-easterly direction, and crossing the Red Deer and Little Red Deer Rivers, we emerged on the Great Plains, following a route seldom taken by the white man.

On the 18th September, we reached the South Saskatchewan, here called the Bow River, but owing to the difficulty of finding a practicable ford, did not succeed until the following day in effecting a passage with our horses and baggage. Whilst carrying out this operation, the Assiniboine Indian deserted, but subsequently rejoined the party, fearing, probably, to be left alone in the country of the Blackfeet, the hereditary enemies of his tribe. We found the water here of the South Saskatchewan, icy cold, flowing as it does out of immense glaciers in the Rocky Mountains.

On the 21st September we reached the north-west bank of the Porcupine Hills, and when almost at the foot of the Livingstone Range of the Rocky Mountains, about eighty miles to the north of the International Boundary line, our progress was stopped by a violent snow-storm, and we were forced to camp on the open prairie. For two days and two nights it snowed without intermission, the mountains were soon

covered, and by the evening of the 22nd the snow lay two feet deep all over the plain. The situation became somewhat difficult—stopped at a point 250 miles from the Rocky Mountain House, and as far from any other source of supply, with only five or six days' provisions left, the guide declaring that to cross the mountains had now become impossible. Fortunately the storm occurred before entering the mountains, or the probability is, that the animals would have been lost, and our party placed in a very critical position.

On the 23rd the weather cleared, and on the afternoon of that day we killed a large grizzly bear which had approached to within a few yards of our camp, the animal having lain all the previous night close to it. This event afforded us a timely supply of meat, relieving our anxiety on that point, although in a case of extremity, the horses would have supplied food, it was necessary to save them if possible for transport. We remained snowed up for six days, then, abandoning the cart and all superfluous baggage started on the 27th with the horses for the Kootanie Pass, resolving to push through the mountains if practicable, and if unable to do so to make for Fort Benton, on the Missouri, a United States military post in Montana, distant about 250 miles to the south-east.

Owing to the depth of snow we did not make more than four miles on the 27th.

On the 28th we made about sixteen miles, the snow disappearing rapidly, the weather now very fine, and on the following day clearing the snow altogether (our route lying in a southerly direction), we crossed the Belly River, and reached the south end of the Porcupine Hills, opposite the entrance of the Kootanie Pass, about 50 miles to the north of the International Boundary line.

The country around the Porcupine Hills is justly considered the richest and most beautiful part of the Saskatchewan territory. It is a favourite wintering ground for great herds of buffalo, and of the Blackfeet Indians, who at that season of the year pitch their camps on either slope of the Porcupine Range, or in the sheltered and fertile valleys along the eastern base of the Rocky Mountains.

During the nights of the 27th, 28th, and 29th, we kept on the alert, having during the day time observed the fresh trail of a mounted man, keeping always a short distance in advance of our party, but never visible to us. From certain signs well understood by the guides from their knowledge of Indians and Prairie life, they were of opinion that we were being watched at this time by some scout belonging to a hostile party of the "Gros Ventre" or "Crow" Indians from south of the line, with a view to horse stealing; it was necessary therefore to keep the horses close to us at night and well hobbled, and to keep a look out for our own safety.

On the 30th September, when entering the Kootanie Pass, we observed a mounted Indian galloping along the side of a mountain. After some hesitation this Indian approached, and on finding that we were not a party of the dreaded Blackfeet, he exhibited great pleasure. He proved to be a scout belonging to a band of Kootanie Indians who had crossed the mountains from the Western side, to hunt buffalo on

the Eastern Prairies. After proceeding a few miles accompanied by this man, and passing several mounted Indians, posted as scouts on the look-out, we met the main body of the band on the march, and at the request of the chief, camped and remained a day with them, being treated in the most friendly manner. There were about sixty or seventy men in the band, exclusive of those scouting; they had with them more than 200 horses, among which were some good animals; most of the men were armed with guns, some carrying revolvers in addition; a few, however, were only equipped with bows and arrows, war axes and knives. Although not actually at war with the Blackfeet, they were apprehensive of attack, and the manner in which these poor Indians performed outpost duty, would have taught a lesson to the soldiers of more civilized countries. One of the leading men insisted upon presenting us with a horse, and when I expressed a desire to obtain one or two of their men as guides, and to assist in crossing the mountains, the chief directed three to accompany us as far as we wished.

The Kootanie Indians from the western side of the mountains are much more civilized than the Crees or Blackfeet (these latter as regards habits of life being little better than mere animals). During the day I was with the Kootanie band, a bell was rung three times in the camp for prayers. They are noted hunters, good horsemen, and were quite prepared for a brush with the Blackfeet if called on.

Continuing our journey we crossed the Rocky Mountains in two days, riding and scrambling over rough ground. Owing to the quantity of fallen timber, some of which was of great size, we experienced considerable difficulty in getting the horses through, but except on the summit of the Pass, there was no snow on the trail.

The weather was then, on the 1st of October, very fine and quite mild. On the 4th of October, by which time the provisions were exhausted, we reached the Gold Miners' camp of Wild Horse Creek, in the Kootanie District of British Columbia, where we were most hospitably received by the Gold Commissioner and Stipendiary Magistrate of the district, Mr. Arthur Vowell, and our wants supplied.

In crossing the Rocky Mountains by the Kootanie Pass, there are two distinct ranges. The height of the summit of the first pass is about 6,300 feet above the sea—the mountains on either side, however, being double that altitude and capped with perpetual snow. The height of the second pass is nearly the same; the track is well defined, and has been used for many years by the Kootanie Indians. In some places the path is very narrow, leading over high and dangerous ground—we found it necessary frequently to dismount. The distance from the eastern to the western entrance of the pass in the Kootanie Valley is about 47 miles. It would be difficult to describe, in adequate language, the beauty and grandeur of the scenery all through. It is impossible to take any wheeled vehicle at present through the Kootanie, and when there is snow in the mountains in any quantity, horses cannot pass. The present horse trail, however, might be easily improved—a party of fifty men could, in the course of a single season, make it equal to the ordinary horse trails in the Province of British Columbia. Considerable labour however would be required to make a

waggon road, and to carry a railway across the mountains by this pass, it would be necessary to tunnel through two mountains.

The Stipendiary Magistrate of the Kootanie district, British Columbia, resides at Wild Horse Creek; there is a population of from twenty-five to thirty white men, gold miners there, and about one hundred Chinese. The miners, at that time, were not making more, on an average, than five or six dollars per man per day. Ample supplies of beef and flour, at moderate price, can be obtained; but the price of clothing and other supplies is very high, such supplies having to be brought on mules or pack horses, either from Walla Walla, in Washington Territory, United States, or from the town of Hope, on the Fraser river, British Columbia, a distance of four hundred and fifty miles.

A custom-house has been established at Joseph's Prairie, about 14 miles from Wild Horse Creek, with excellent effect; and if a similar one was established on the eastern side of the mountain with a military guard at the Porcupine Hills, a still better result would be obtained.

The postal communication from the Kootanie District to Victoria, is as yet very bad, and it is very desirable to improve the present trail leading *viâ* Osoyoos and the Simil-Kameen to the town of Hope, on the Fraser, or to make a waggon road.

The district of Kootanie is of great extent, embracing an area of 32,000 square miles. The total population amounts to about eighty-five white men, two hundred Chinese, and 400 or 500 Kootanie Indians. There is an immense quantity of fine timber in the Kootanie District, and in the valleys of the Rocky Mountains, chiefly cedar and pine trees of great height and size; and the mineral resources are believed to be very great. The valleys between the different hill ranges in the Kootanie District are, generally speaking, fertile and well adapted for farming. There are four gold mines in the district, namely, Wild Horse Creek, Perry's Creek, Palmer's Bar, and Weaver's Bar—only the two former, however, are being worked.

The government of the district was at the time of my visit under the able administration of Mr. A. Vowell, Stipendiary Magistrate and Gold Commissioner.

"Wild Horse Creek," although situated in a lovely country, is itself one of the most desolate spots imaginable; a narrow rugged valley, surrounded by lofty hills, in the heart of the Rocky Mountains. From Wild Horse Creek, the guides who had accompanied me from the Rocky Mountain House, after obtaining fresh supplies, started on the 8th of October to return to the Rocky Mountain House, intending to take what they hoped might prove a shorter route, and one safer from risk of Indian molestation.

After my return to Ottawa, I learnt that they effected the return journey to the Rocky Mountain House with safety in eighteen days, recrossing the mountains by the Ispasquehow Pass; ten days were occupied in crossing the mountains, and much difficulty encountered —two of the horses rolled down an immense ravine, but were fortunately not much hurt. The Assiniboine Indian deserted the two other guides in crossing the mountains, thereby greatly increasing their

labour. Arriving at the spot where the cart had been "cached," the two guides recovered it, and returning from thence by the route originally taken, reached their home at the Rocky Mountain House towards the end of October without accident or the loss of a horse. These two guides alone completed a trying and adventurous journey of several hundred miles with no further damage or deficiency, than the loss of two saddles and an axe. They saw immense herds of buffalo on the return journey, and at the Bow river fell in with a party of American smugglers, having waggons with them, containing whisky and ardent spirits, with which to carry on their illicit and nefarious traffic with the Blackfeet tribe—a kind of traffic which enables these unscrupulous traders to realize large profits, rob the Indians of buffalo robes, and valuable furs, and causes annually certain bloodshed amongst the Indian tribes.

On the 8th October with one guide only and five horses obtained at Wild Horse Creek, I continued the journey from there, and after fifteen days' travel, proceeding *viâ* the Mooyie River, Lake Pen d'Oreille, the Spokane and Snake Rivers, arrived at the settlements of Walla Walla and Walula, in Washington Territory, United States.

It had been my intention to proceed from "Wild Horse Creek" to the town of Hope, on the "Fraser," a distance of about 500 miles, *viâ* Fort Shepherd, Lake Osoyoos, the Okanagan country, and Similkameen River, but owing to the lateness of the season the guide was unwilling to take this route.

The journey from Wild Horse Creek to Lake Pen d'Oreille was tedious and fatiguing, having only one guide to share with me and my son the labour of travelling with horses for many days along an Indian track encumbered with fallen timber, and through a rugged, densely wooded, and difficult country. The scenery from Wild Horse Creek to Lake Pen d'Oreille, and especially about that lake, is very beautiful; but further south, on reaching the Spokane River, United States, the country presents the appearance of an arid waste; Washington Territory, United States, being partly situated in what is known as the great Columbian Desert. Washington Territory, United States, is, however, as well as many parts of British Columbia, admirably suited for horses and cattle, from what is known as "bunch grass," growing there in great perfection.

From Walula, descending the Columbia, I proceeded, *viâ* Portland, in Oregon, Olympia, and Puget Sound, to Victoria, in Vancouver's Island, arriving at Victoria on the 28th day of October, having accomplished the journey from Fort Garry in 70 days, of which only 51 were occupied in actual travel,—the distance by the route followed from Fort Garry to Vancouver's Island being nearly 3,000 miles,—of this distance considerably more than 2,000 miles were travelled on horseback. After remaining 14 days at Victoria, visiting the Island of San Juan, in company with the senior naval Officer of H.M.'s ships, and arranging for the organization of the Militia in the Province of British Columbia, I returned to Ottawa, *viâ* San Francisco and the United States Pacific Railway, stopping for two days to visit the Mormon City, at the Great Salt Lake in Utah Territory.

Chapter V.

General Remarks.

During the journey from Manitoba to the Pacific Coast, an opportunity was afforded me of becoming acquainted with the state of affairs in the Saskatchewan and the condition of the Indian tribes. Every possible information was furnished by the missionaries whose acquaintance I made, and by the *employés* of the Hudson's Bay Company; in the course of the journey I met with many bands of Indians.

Between Fort Garry and Portage de la Prairie, three large camps of the Sioux tribe were visited; a portion of the same band who in 1862 massacred some American settlers in Minnesota, United States, in retaliation for the many wrongs and outrages committed in the first instance on them by American citizens. Ever since that event, this band has sought refuge in Dominion territory. These Sioux Indians live quietly enough apparently among our people, and occasionally assist the farmers at harvest time. The presence, however, of such a wild and warlike-looking band in the settlement frequently causes no small apprehensions amongst the settlers dwelling near Portage de la Prairie; and it should be remembered that at the time of the Minnesota massacre this very band, although living quietly apparently among the Minnesota settlers, rose suddenly in one night and swept the settlement, committing horrible atrocities. Before reaching Fort Ellice I met two bands of the same tribe, one consisting of about 100 men, unaccompanied by women or children, who told me they had been to visit the Lieutenant-Governor of Manitoba in hopes of obtaining presents. This band belonged to the United States, and had come all the way from the plains south of the Missouri River, whither they were returning. These Indians were bold and wild-looking fellows, fantastically dressed, and all armed. They were perfectly friendly in their manner.

On one occasion, when far out on the prairie, a band of 10 mounted Sioux, after reconnoitring from a distance, rode rapidly towards our small party of four (two of whom were only boys), surrounding us in a moment; on being told by the guide, who spoke their language very well, that I was not an American citizen, but a British Officer travelling towards the Rocky Mountains, they became quite friendly in manner, shaking hands with us heartily. Subsequently this band were somewhat bold and pressing in their demands for presents, which we resisted in a firm but friendly manner, it being bad policy to comply with extortionate demands, or to appear in dealing with Indians, to act from intimidation.

Between Fort Ellice and Fort Carlton I met some bands of the Saulteaux tribe; at the various forts along the North Saskatchewan several of the Cree tribe (plain Crees), and at the Rocky Mountain House, some Blackfeet and Assiniboine Indians.

Although there may not at present be much risk in travelling through Saskatchewan territory along the well-known track followed for so many years by the Hudson's Bay Company, especially when associated

with an *employé* of the company speaking the Indian language, it is a matter of doubt if such can long continue under the changing state of affairs, *without the introduction of some Government supported by material force.*

Beyond the Province of Manitoba, westward to the Rocky Mountains, there is no kind of Government whatever at present, and no security for life or property beyond what people can do for themselves. The few white men there are in the Saskatschewan country and at the Hudson's Bay Company Forts, frequently expressed to me their conviction that, unless a military force be established in the country, serious danger is to be apprehended. The clergy of all denominations whom I met with expressed similar convictions; those at Forts Victoria and Edmonton, as representatives of the community, urged me in the most impressive manner to lay their claims for the protection of themselves, their wives, and families, before his Excellency the Governor-General of the dominion and the Government of their country. It appears that of late years no attempt has been made to assert the supremacy of the law, and the most serious crimes have been allowed to pass unpunished. Hardly a year has passed without several murders, and other crimes of the most serious nature, having been committed with impunity.

During the present year, about three weeks before my arrival at Edmonton, a man, by name Charles Coudin, a French-speaking half-breed, cruelly murdered his wife at no great distance from the gate of the Hudson's Bay Company's Post. I was informed that the criminal might have been arrested, but that there was no power to act. This same man had previously most wantonly and cruelly mutilated an old Indian woman by cutting the sinews of her arm so as to incapacitate her for work.

At Edmonton there is a notorious murderer, a Cree Indian, called Ta-ha-kooch, who has committed several murders, and who should have been apprehended long ago. This man is to be seen walking openly about the Post. Many instances can be adduced of a similar kind, and as a natural result, there is a wide-spread feeling of apprehension. The gentleman in charge of the Hudson's Bay Company's Post at Fort Pitt, as well as others elsewhere, assured me that of late the Indians have been overbearing in manner, and at times threatening. Indeed, the white men dwelling in the Saskatchewan are at this moment living by sufferance, as it were, entirely at the mercy of the Indians. They dare not venture to introduce cattle or stock into the country, or to cultivate the ground to any extent, for fear of Indian spoliation.

When at Edmonton and the Rocky Mountain House, I was informed that a party of American smugglers and traders have established a trading post at the junction of the Bow and the Belly Rivers, about 30 miles due east from the Porcupine Hills and about 60 miles on the dominion side of the boundary line. This trading post they have named Fort Hamilton, after the mercantile firm of Hamilton, Healy, and Company, of Fort Benton, Montana, United States, from whom it said they obtain supplies. It is believed that they number about 20 well-armed men, under the command of a man called John Healy, a

notorious character. Here it appears they have for some time carried on an extensive trade with the Blackfeet Indians, supplying them with rifles, revolvers, goods of various kinds, whisky, and other ardent spirits, in direct opposition to the laws both of the United States and the dominion of Canada, and without paying any custom duties for the goods introduced into the latter country. The demoralization of the Indians, the danger to the white inhabitants, and the injury resulting to the country from this illicit traffic, are very great.

It is stated upon good authority that during the year 1871, 88 of the Blackfeet Indians were murdered in drunken brawls amongst themselves, produced by whisky and other spirits supplied to them by those traders. Year after year, these unscrupulous traders continue to plunder our Indians of their buffalo robes and valuable furs by extortion and fraud, and the shameful traffic causes certain bloodshed amongst the Indian tribes. At Fort Edmonton during the past summer, whisky was openly sold to the Blackfeet and other Indians trading at the Post by some smugglers from the United States, who derive large profits thereby; and on these traders being remonstrated with by the gentlemen in charge of the Hudson's Bay Post, they coolly replied that they knew very well that what they were doing was contrary to the laws of both countries, but as there was no force there to prevent them, *they would do just as they pleased.* It is indispensable for the peace of the country and welfare of the Indians, that this smuggling and illicit traffic in spirits and fire-arms be no longer permitted. The establishment of a custom-house on the Belly River near the Porcupine Hills, with a military guard of about 150 soldiers is all that would be required to effect the object. Not only would the establishment of a military post here put a stop to this traffic, but it would also before long be the means of stopping the horse-stealing expeditions carried on by hostile Indians from south of the line into Dominion territory, which is the real cause of all the danger in that part of the country, and the source of constant war among the Indian tribes.

Indeed it may now be said with truth, that to put a stop to horse-stealing and the sale of spirits to Indians, is to prevent altogether Indian wars in the north-west. The importance of the Porcupine Hill in a strategical point of view is very great, commanding as it does the entrance of both the Kootanie passes towards the west, and the route from Benton into the Saskatchewan territory on the south and east; the country can be seen from it for immense distances all round. Although hostile to citizens of the United States, it is believed that the Blackfeet Indians would gladly welcome any Dominion military force sent to protect them from the incursions of other tribes, and to stop the horse-stealing which has for so long been carried on. With excellent judgment they have pointed out the southern end of the Porcupine Hill as the proper place for a military post. In order to satisfy myself on this point, I spent the greater portion of the 29th September in reconnoitring the ground recommended by them, and if it be the policy of Government to take steps to stop the illicit smuggling which is being carried on at this part of the Dominion, there is every convenience for establishing a custom-house and military post. Timber

of large size and good quality for building is close at hand; and the surrounding country is most fertile and favourable for settlement.

The distance from Fort Edmonton to the Porcupine Hill is about six or seven days' journey on horseback, and from the Kootanie Valley on the western side of the Rocky Mountains, from whence supplies could be easily obtained, about fifty or sixty miles.

Frequent intercourse, and an active trade between the Kootanie district of British Columbia and the Saskatchewan country, would result from the establishment of a custom-house and military post at the Porcupine Hills. Many individuals are prepared to settle there, if any protection is afforded, and the Indian trade of the country, at present tapped by United States' smugglers, would remain with our own countrymen. There is a general belief prevalent, moreover, that valuable gold deposits are to be found near the Porcupine Hills; the unsettled state of the country hitherto has not admitted, however, of much prospecting. A party of four American miners who crossed through the Kootanie Pass two or three years ago, were all killed by the Blackfeet, near the Porcupine Hill, the moment they entered the plain on the eastern side; since which no attempt at prospecting for gold has been made in that part of the country.

With regard to the measures which should be adopted for the settlement of the country, I feel satisfied that the introduction of a civil police force, unsupported by any military, into the Saskatchewan territory would be a mistake, and that no time should be lost in establishing a chain of military posts from Manitoba to the Rocky Mountains. The appointment of a stipendiary magistrate for the Saskatchewan, to reside at Edmonton and act as the Indian Commissioner, is also a matter of the first importance. The individual to fill this important post should be one, if possible, already known to, and in whom the Indians have confidence. I consider that it is very necessary to invite the co-operation of the Hudson's Bay Company in the adoption of any steps towards establishing law and order in the Saskatchewan for the first few years, and no Indian Commissioner should proceed unaccompanied by a military force. A large military force is not required, but the presence of a certain force I believe will be found to be indispensable for the security of the country, to prevent bloodshed, and preserve peace.

The number of the Indians dwelling in the extensive country which lies between the Red River and the Rocky Mountains on Dominion territory has been much exaggerated. It is very difficult to arrive at any accurate Indian census, but having made every inquiry during last summer on this point, whilst travelling through the country, from those most competent to judge, I doubt if there are more than 4,000 Prairie Indians capable of bearing arms in the Dominion territory, between Fort Garry and the Rocky Mountains, south of the Sub-Arctic Forest, and north of the International Boundary Line, the total Prairie Indian population amounting, perhaps, to 14,000 or 15,000. These Indians are scattered over such an immense extent of country that anything like a formidable combination is impossible; most of the tribes, moreover, have been hostile to one another from time immemorial.

It is believed that the Blackfeet and the Plain Crees, the two

strongest tribes of Prairie Indians, may have respectively about 1,000 fighting men, but it is doubtful if either tribe could ever concentrate such a number, or if concentrated, that they could long remain so from the difficulty of obtaining subsistence. Although many of the Blackfeet have breech-loading rifles, the Indians generally are poorly armed and badly mounted. Under these circumstances it will be readily understood that comparatively small bodies of well-armed and disciplined men judiciously posted throughout the country, could easily maintain military supremacy. A body of 50 mounted riflemen armed with breech-loading rifles is a formidable power on the prairies.

One regiment of mounted riflemen, 550 strong, including non-commissioned Officers, divided into companies of 50, would be a sufficient force to support Government in establishing law and order in the Saskatchewan, preserving the peace of the north-west territory, and affording protection to the surveyors, contractors, and railway labourers about to undertake the great work of constructing the Dominion Pacific Railway.

Although the proposed military strength, and consequent expense, may appear somewhat considerable, I have been guided by every consideration of economy in recommending the above number. It is wiser policy and better economy to have 100 soldiers too many, than one man too few; the great extent of the country, and detached nature of the service, must also be taken into account, and it should be borne in mind that the only thing the Indians really respect and will bow to, is *actual power*. It should be borne in mind too, that in addition to the Indian element, there is a half-breed population of about 2,000 souls in the Saskatchewan, unaccustomed to the restraint of any government, mainly depending as yet upon the chase for subsistence, and requiring to be controlled nearly as much as the Indians. If it be in harmony, therefore, with the policy of the Government to do so, I would recommend the establishment of military posts at the following places, strength as below:—

Mounted Riflemen.

1. At Portage de la Prairie, 50; 2. at Fort Ellice, 50; 3. at Fort Carlton, 50; 4. at Fort Pitt, 50; 5. at Fort Victoria, 50; 6. at Fort Edmonton, 100; 7. at Porcupine Hill, 150; total, 500. With a proportion of Officers and non-commissioned officers.

If no permanent custom-house and military post is established at the Porcupine Hills, then the strength of the force at Edmonton should be 250, of which 150 men should be encamped during the summer months at the Porcupine Hills, or at the junction of the Bow and Belly rivers, returning to Edmonton for the winter; but the establishment of a custom-house and military post at Porcupine Hills, is of far more importance, and would have a much better general effect towards securing the peaceful settlement of the country than at any other places named. During the summer months a detachment of 50 men from this post might with advantage be employed in improving the communication across the mountains with the Kootanie district of British Columbia.

It would be necessary that each of the companies of mounted riflemen should be made, as far as possible, self-supporting communities, provided with a few carts, entrenching tools, agricultural implements, seed for raising corn, and some cattle. These military posts would partake of the character of military settlements, in the vicinity of which many settlers would, ere long, establish themselves.

It would be very desirable, moreover, that a medical officer should be appointed to each military post, and his duties not confined to the medical charge of the military only, but extended to all the Indians in the vicinity. Past experience has proved that no measure is better calculated to secure the confidence and attachment of the Indian tribes than by attending to their wants in time of sickness, and supplying them with medical aid.

The men to compose the corps should be enlisted to serve for three years, receiving on the termination of the engagement (provided they have performed their duties in a satisfactory manner), the same amount of land as is granted on discharge to the men of the militia in Manitoba; I would recommend that the corps be raised by volunteers from the active militia. It would be desirable to attach to the military force at each post, three or four half-breeds, or Indians, as scouts, who could serve as interpreters, and would usually carry the mail.

At the places indicated for military posts, no great difficulty would be experienced, or expense incurred, in hutting the men, they themselves performing the work, or an arrangement might be more easily made with the Hudson's Bay Company to provide barrack accommodation and rations at the different posts for the number of men required.

In the event of this proposed arrangement meeting with the views of Government, I have the honour to state that the probable expense that would be incurred for the establishment and maintenance of the militia force proposed, would be about 300,000 dols. annually.

I would further beg to suggest, if it be decided to establish any chain of military posts, that for the first year the soldiers be employed in laying down a telegraphic wire from Manitoba towards British Columbia, if not required to hut themselves.

From my own knowledge and observation of the country, I think that if proper energy be used, the very desirable work of establishing telegraphic communication, from Fort Garry through Dominion territory, with British Columbia, could be carried out by the soldiers in one or two seasons. I would further observe that no time should be lost in making the preliminary arrangements. The men and horses should, if possible, be concentrated at Fort Garry in the month of May or June, their equipment forwarded sooner, and the companies despatched without delay. An easy and agreeable march of a few weeks' duration would suffice to establish them in the respective posts of occupation.

BRITISH COLUMBIA.

With regard to the organization of the militia in British Columbia, it is recommended that one Staff Officer as Deputy Adjutant-General of Militia be appointed for the province, as soon as the Government

finds it convenient to do so. It is not necessary at present to appoint Brigade Majors.

The formation of two companies of riflemen (volunteer militia) in Victoria, and one at Nanaimo, is recommended, also the formation of one company of riflemen at New Westminster, another at Burrard's Inlet, on the mainland, and that the New Westminster battery of garrison artillery be reorganized.

The total white population of the province is only as yet about 12,000. There are about 4,000 half-breeds and 45,000 Indians—the latter mainly dwelling along the coast. The Indians dwelling in the interior of British Columbia are not numerous; the policy of treating them much in the same manner as if they were settlers, appears to have succeeded admirably.

The following amount of military stores have recently been despatched by order of the Dominion Government, from England direct by sea to Victoria, for the equipment of the militia of the province:—

1,000 Snider Enfield rifles.
1,000 sets of accoutrements.
1,000 rifle uniforms.
1,000 great coats.
300,000 rounds of ammunition.
60 tents.
20 targets complete, with flags.
100 camp kettles.
1,000 knapsacks complete, with mess tins and straps.

It is very desirable with a view to ultimate economy as well as present efficiency, that some building be acquired in Victoria to serve as an armoury and storeroom, and that a storekeeper be appointed to the charge of this public property without delay.

I submit, with this Report, a map of the north-west provinces and territories of the Dominion, showing the route which I followed across the continent; the places recommended for military posts are marked, and the point where it is stated that United States' smugglers have established a post at the junction of the Bow and Belly Rivers, is also shown.

The portion of territory north of the 49th parallel, and west of the Lake of the Woods, on the "Dawson Route" now claimed by the United States' authorities, and which intersects the present Canadian line of communication with Manitoba and the important territories of the north west is shaded dark.

I have the honour to be, Sir,
Your most obedient servant,
P. ROBERTSON-ROSS,
Colonel Commanding the Militia of Canada,
and Adjutant-General of Militia.

Head-quarters,
Ottawa, 17th March, 1873.

This Report has been submitted to the Dominion Parliament now in Session.

P. R. R.

Evening Meeting.

Monday, March 31st, 1873.

MAJOR-GENERAL SCHOMBERG, C.B., R.M.A., Deputy Adjutant-General Royal Marines, in the Chair.

NAMES of MEMBERS who joined the Institution between the 26th and 31st March, 1873.

ANNUAL.

Cotton, C. McClintock, Major 20th Hussars.
Carr, Fredk. S., Captain 5th Punjab Cavalry.
Hayter, A. D., Lieut.-Colonel London Rifle Brigade.
Maxwell, Patrick, Lieut.-Colonel Bengal Staff Corps.

OBSERVATIONS ON THE MONCRIEFF SYSTEM OF MOUNTING ORDNANCE.

By Lieutenant T. ENGLISH, R.E.

In the paper which I have the honour of reading to-night, I do not propose to enter into any of the mechanical questions connected with Major Moncrieff's invention, but only to consider the subject from the point of view of an engineer, who has to fortify a given position. In such a case, one of the first things to be done is to determine what is the best type of works to erect, and it is to this problem, more particularly with regard to coast defence, that I would call your attention.

At the outset of my paper, too, I would carefully guard myself against offering an adverse opinion on the merits of Major Moncrieff's or of any analogous system, as applied to mounting ordnance on works intended to resist land attack, and where earth is the only material available.

In unstrengthened earthen parapets, the embrazure system becomes more and more dangerous, as the power of rifled shell-guns grows larger. The objections to it are too many and too well known to be worth repeating; and it seems likely that some barbette system, with an unbroken parapet, must be substituted for it. Major Moncrieff's carriage, although it does not reduce the target presented to high angle fire, still allows of so much more horizontal protection than the ordinary barbette carriage, as, wherever its use is practicable, fully to compensate for the extra weight, cost, and complication involved.

For coast defence, however, the arguments both for and against the adoption of Major Moncrieff's system of mounting ordnance, have generally been founded upon the ideal case of a duel between a single gun in a shore-battery and a single gun on board ship; and too little consideration appears to have been given to the various powers of offence of a powerful fleet.

It would, therefore, seem desirable to examine, more closely than has hitherto been done in public, into the conditions which probably would prevail in the attack from the sea, of a harbour or channel, defended by heavy guns and torpedoes.

The risk of loss and disaster, in making such an attack, is, from unavoidable causes, so great, that the enterprize is not likely to be begun unless the command of the sea has been obtained; whilst the most careful preparations will be made before hand, and the means of attack will be so proportioned to the known powers of the defence, as to give, at least, a fair chance of success; unless, indeed, the invader's object be defeated by such defensive arrangements having been made, as will evidently render the position practically impregnable.

To fix the ideas, assume the position to be that of a tidal channel, with a width of half a mile to a mile of deep water, low banks, and reaches from one to three miles long, with bends approaching right angles between them.

Assume also, that forty heavy guns are available for the defence, twenty of them being of twelve-inch, and twenty of ten-inch calibre, and that a complete system of torpedoes has been laid down.

It will, I think, be the general opinion of those who have studied the subject, that, to reduce such a position, if properly defended even by artillery fire alone, would require a fleet carrying at least the same number of heavy guns.

We may, therefore, assume that the attacking force must consist of, at least, four turret ships of the heaviest type, each carrying four twelve-inch guns, or their equivalents, and protected by twelve or fourteen inches of iron, so as to be practically invulnerable at moderate ranges, and only to be disabled by shot entering the ports, or by the turrets being jammed.

These vessels would be supplemented by, say, six broadside sea-going ships, of moderate armour, seven or eight inches thick, but strengthened and prepared, for this special duty, by taking out their masts and all superfluous weights, and by adding extra plating along their waterlines and batteries, so as to bring their resisting power at the most vital parts, on a par with that of the turret ships.

Each of these vessels may be assumed to carry eight ten-inch guns, four on each broadside; and two ships of their number would be kept in reserve.

The fleet would still require unarmoured gun-boats of light draught, say fifty in number, twenty to be kept in reserve; each of two hundred or three hundred tons, and carrying two nine-inch rifled howitzers or their equivalents, capable of being trained into any position, though only one would probably be used at a time.

Hence we have an attacking force, which can be concentrated on any point, of

16	12″	guns in four turret ships,
16	10″	guns in four broadside ships,
30	9″	howitzers in thirty gun-boats,
Total 62		pieces of ordnance;

and of the thirty-two guns above enumerated, it must be remembered that any can be replaced by howitzers, if required.

Even putting torpedoes on one side for the present, as having been removed or destroyed, an attacking force cannot afford either to neglect heavy batteries or to attempt to pass them, silencing them only for a time; for, unless they are totally destroyed and occupied, they will form a complete obstacle to the maintenance of communications and supplies, and, by the facilities they would offer, if not taken, for the re-establishment of torpedoes, (the removal of which must be a work of time,) they might seriously compromise the safety of the attacking fleet, in the event of a retreat being from any cause necessary. But the use of torpedoes has improved the defence, and considerably altered the conditions of the problem, by compelling the enemy to take up a definite position, chosen by the defenders; that is, in the water from which the torpedoes can be removed or destroyed without the possibility of re-laying.

This water-space would include all within view of the hostile fleet and under the fire of its guns, whilst the fleet keeps out of range from the forts. Where bends in the channel, or the forts themselves, prevent a view from the fleet, it is not likely that much difficulty will exist in renewing torpedoes, even if removed.

I should conceive that the plan of operations would be somewhat as follows:—The fleet would anchor at a safe distance below the batteries, and probably spend several days in clearing away torpedoes, by sending gunboats and steam launches, whenever darkness permitted, either to pull them up, to cut the cables, or to explode them in place.

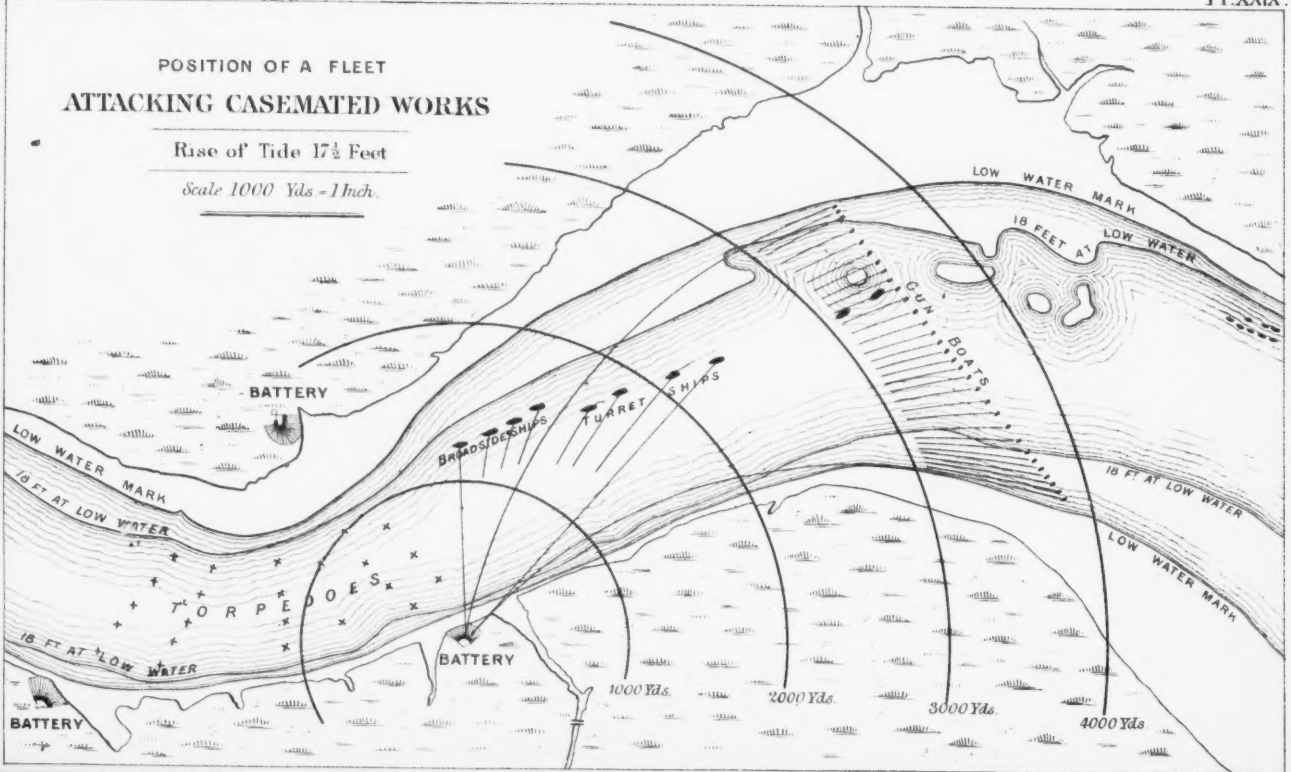
Some of the armoured vessels would advance at daylight, to within long range of the works, so as to prevent, by their fire, any possibility of torpedoes being re-laid; retiring at dusk to a safer anchorage, and to give place to the boats.

By these means a channel could probably be cleared of all submarine obstructions, in the course of three or four days, to a distance sufficient to allow the fleet to take up its position for attacking the batteries; the limit of clearing being, as before stated, where the channel stretched out of range and sight of the fleet. Probably several, and possibly many boats and small vessels would be lost during these operations, but it would appear to be out of the power of the defenders to do more than hinder them.

If the channel could not be cleared in the manner indicated, it would appear certain that the expedition must fail, for no Commander would, I think, dare to carry his ships through a narrow channel where torpedoes were known to exist.

The attack in force would obviously be varied according to the nature of the defence to be overcome; but, assuming first that the guns on shore were mounted in casemates, I should imagine that the most effective and formidable method of attacking would consist in the armoured fleet advancing, against the tide, in single column, through the channel cleared of obstructions, until nearly abreast of the lowermost works; when, as in the bombardment of Fort Fisher, in the American war, they would drop anchor at about 200 yards distance

Journal R.U.S Institution
Vol. 17.



J. Jobbins

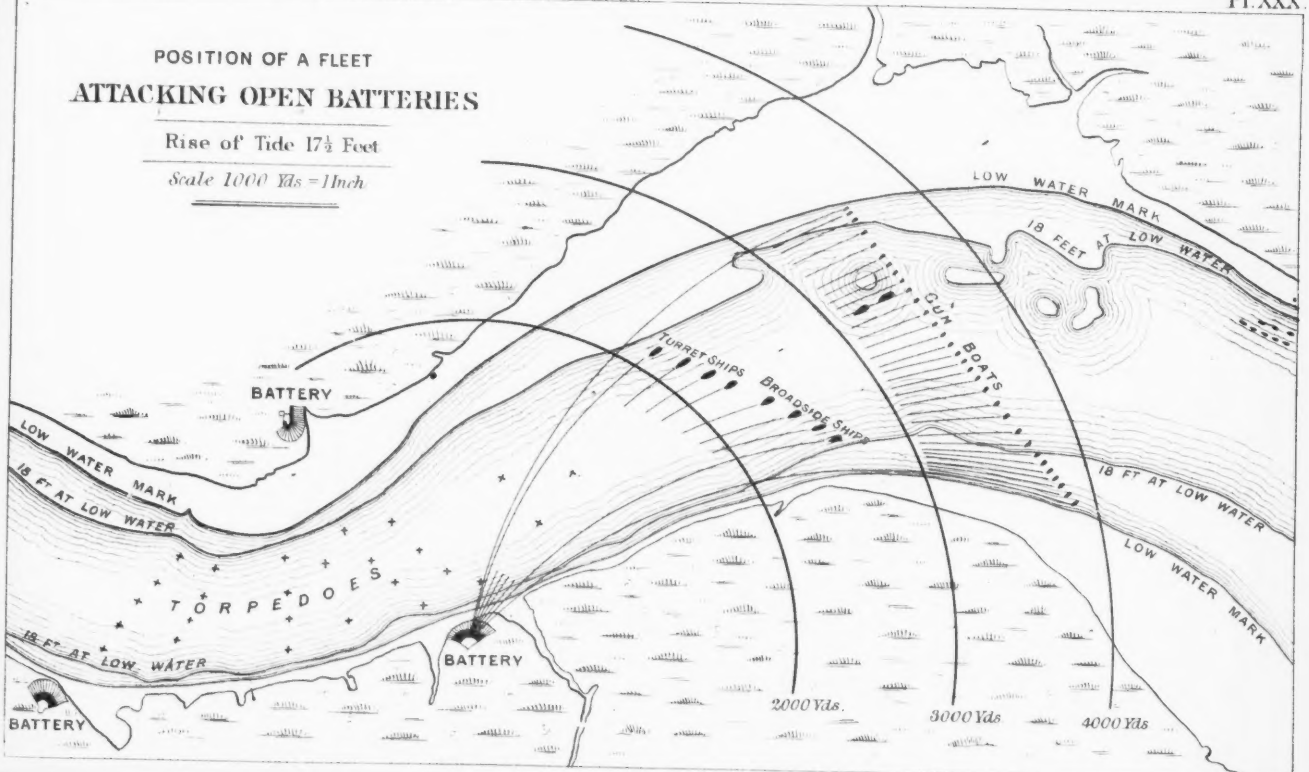
J. Jobbins

POSITION OF A FLEET

ATTACKING OPEN BATTERIES

Rise of Tide 17½ Feet

Scale 1000 Yds = 1 Inch



J. Jobbins

apart, the column taking up about a mile in length. They would then concentrate all their fire, by signal, with battering charges, upon one of the works furthest down the channel, at ranges varying from 1,000 to 2,500 yards (see Plate xxix). When the guns attacked were silenced, the fire of the whole fleet would be transferred to the next, and so on; some of the vessels weighing anchor and taking up fresh positions, if required.

At the same time, the gunboats will have followed the heavy ships at a considerable interval, and will have kept up a continuous fire of shells, at as close a range as they could venture to without drawing fire upon themselves, say from 3,000 to 4,000 yards, upon the same guns with which the ships were engaged.

If, instead of casemated works of defence, open batteries were to be engaged, I imagine that much the same general method of attack would be followed, except that the fleet would come to an anchor at a considerably greater distance from the works, say the nearest vessel being 2,000 yards from the outermost battery, and would commence a high angle shell fire on each work in succession, until silenced, the ships moving up into fresh positions, as required (see Plate xxx).

Such being the conditions of attack, it remains to be considered what disposition of guns is likely to give the most effective defence.

It is clear that the more the available guns are distributed along the banks of a channel, the less obstacle will each one present to the systematic carrying out of the process of silencing them described above; for, with a number of detached guns, or small works defending a channel, the enemy will gradually advance, clearing away the torpedoes and reducing the batteries singly, with comparative ease.

The cardinal principle of the defence would therefore appear to be, to concentrate such a weight of fire—not on one point only, but upon the whole position which the attacking fleet is compelled, by the presence of torpedoes, to occupy, that is, upon a front a mile long—as shall silence the enemy's guns in the shortest possible time. If such a defensive position is taken up, the enemy cannot bring any of his ships within range close enough to do much harm to the batteries, until the time he may choose, after much preparation, for a combined effort with his whole strength, when many circumstances may occur to prevent his success.

Assuming, however, that the ships are brought into the position described for commencing the attack, it will clearly be not worth while for the batteries to waste ammunition upon gun-boats at extreme ranges: they would seldom be hit, and if all were sunk or disabled, it would not decide the fate of the action; but if the heavy vessels can be silenced, the gun-boats will be incapable of further harm.

As more experience is gained in the manipulation of heavy ordnance, it appears more and more certain, that where a number of guns are to act in concert, it will be necessary to control and direct their fire from signal stations at a distance, free from the smoke and confusion which must exist in a battery of any sort; and this circumstance will exercise a powerful influence upon the tactics of the defence. For, as it will be impracticable, for obvious reasons, to signal separately to

each gun, it follows that a battery must be divided into sections, all the guns in one section concentrating their fire upon one object, of which the range and direction are communicated and corrected from the signal station.

We may therefore assume that, in the case under consideration, the forty guns in battery would be divided into eight sections of five guns each. It will be impolitic to concentrate the fire of all the sections upon one ship, as might at first sight seem desirable, for the reason that the value of fire from a land-battery is entirely different from that from a fleet. On shore, with a steady platform, it is possible to correct each shot by the previous one, and so to throw nearer and nearer the object until the errors of aim are eliminated, or nearly so; on board ship, however, the unavoidable motion, caused even in still water, and at anchor, by the recoil of the guns, is sufficient to prevent much advantage in aiming being taken of the results of previous rounds, and the object of a fleet will be to concentrate its whole weight of fire as nearly as possible on one spot, so as to ensure some shots taking effect; and even if this be done, the fire will be more than sufficiently scattered, whilst if it were distributed over the whole position attacked, the results would, I think, be small indeed.

It would seem best, that the fire of any section of the batteries should be continuously directed against the same gun on shipboard, until it is silenced, and by this means the fleet will be most speedily disposed of. But the fire of only one section should be directed against each ship, for otherwise it would be impossible for an observer to correct the aim of the section which he was controlling, as he would not be able to identify the results of its fire.

It will, I think, be next to impossible to sink a ship protected by twelve or fourteen inches of iron, during action, in smooth water, by artillery fire; few, if any, shot would enter below the water-line, and the resistance of armour increases so rapidly with the angle of impact, that it will not be worth while to attempt to do more than to disable the guns, and this would appear to be most readily effected at short ranges, by firing Palliser projectiles at the ports.

As it is plainly desirable, that besides concentrating the guns upon a front, say, a mile in length, the batteries should prevent as much as possible of the channel above them from being seen by the enemy; and as, from what has been already advanced, it appears that torpedoes have put it in the power of the defenders to choose their own ground, it will be best to occupy a bend in the channel, other things being equal, rather than part of a straight reach.

From the foregoing considerations, it will be seen that unlimited lateral range is not of vital importance to shore batteries; the guns are placed to defend a certain definite position, each has its own work to do, and can do it without firing all round the circle; for, from the impossibility of more than one ship occupying the same water at one time, the guns of a fleet cannot be, upon the average, less than fifty yards apart, and a moderate amount of lateral range will enable the batteries to employ their guns to advantage in all positions the ships can take up.

The one advantage of extreme lateral range is to provide against the rather improbable case of one or of a small number of vessels attacking a number of heavy batteries; they would certainly be silenced in a time, diminishing in proportion to the number of guns which could be brought to bear upon them; but it is scarcely worth while to discuss this case, for, judging from every successful sea-attack hitherto carried out, the number of vessels in a fleet designed to attack shore batteries, will always be considerable.

The expense of foundations, gorge buildings, and other accessories, presents an insuperable obstacle to the otherwise desirable plan of spreading the guns about as much as possible, within the limits of being able to concentrate upon a fleet, and it is, I think, quite impracticable to get over this difficulty by planting guns about in the mud, without any foundations at all, as has been proposed.

It should also be remembered that the cost of foundations is a necessary evil, which does not add in the slightest degree to the offensive power of a battery, and should be kept down as much as possible.

Assume, therefore, that three sites are chosen, on which to mount forty guns. It will be advisable to have guns on each side of the channel, for it will clearly be the better for the defence, whether casemates or open batteries are used, to compel the fleet to approach as close to the works as possible. Twenty guns may then be taken as placed in a battery, at a point where the shore forms a salient angle, and ten guns in each of two batteries in the corresponding re-entering angle formed by the opposite shore.

It will, I think, be impracticable to hide the whereabouts of a heavy gun in action;—it is possible, no doubt, completely to screen its exact position until firing commences, but it will be within every one's observation that the puff of smoke, produced by the discharge of a heavy gun, is one of the most prominent objects in any landscape; also, at any rate in this country, with the publicity afforded by the newspaper press to every detail of the defences, it would probably be found, in the event of war, that the position and nature of every gun was carefully laid down on the large scale charts of the estuaries and harbours, with quite sufficient accuracy to ensure the range and direction being known, within 50 yards, from any position a vessel could take up.

It may be estimated that the guns of the fleet all being concentrated upon one spot, the fire would converge through a horizontal angle of from 60° to 90°, and might descend at angles with the horizon, varying from say 50° to 3°.

Having arrived at this point in the problem, the difficulty arises that, if cover overhead is given against such a bombardment, the protection in front must be, to some extent, reduced to enable the gun to fire, as in a shield with a port; whilst if the protection in front remains intact, as in a barbette battery, the overhead cover must be abandoned altogether.

It will, therefore, be necessary now to examine which of these two systems will give theoretically the best resistance, assuming that each is attacked by the description of fire most dangerous to it.

Taking first the case of a casemate fitted with an iron shield, or of an open battery fitted with a similar shield and overhead cover;—in the absence of data which can only be provided by the experience of an actual bombardment, it will be evidently a waste of time to speculate as to the probable area covered by the fire of the whole fleet. We can, however, by the help of the reports of practice carried out for range and accuracy, form a good estimate of what any piece of ordnance can do under the conditions most favourable to it, and for purposes of comparison of the defensive powers of two systems, as measured by the offensive powers of the most dangerous fire that can be brought against each, I think we can arrive at sufficiently accurate conclusions.

It may be assumed that the vulnerable parts of a casemated work protected by iron shields, consist of the ports through which the guns fire, and of a certain margin round them. (See Plates xxxi, xxxii). This margin I have taken as six inches, for the reason that, in the trial of the sample iron shield, No. 31, at Shoeburyness, in March, 1870, a ten-inch Palliser shot which struck seven inches from the edge of the port, went straight into the substance of the shield, not being influenced in any way by the near neighbourhood of the opening. As the port may be taken to be a rectangle of 2′ 7″ + 4′ 0″, the greatest vertical target presented by it and the margin round it may be considered as a rectangle of 3′ 7″ × 5′ 0″, the breadth diminishing with the horizontal angle of impact.

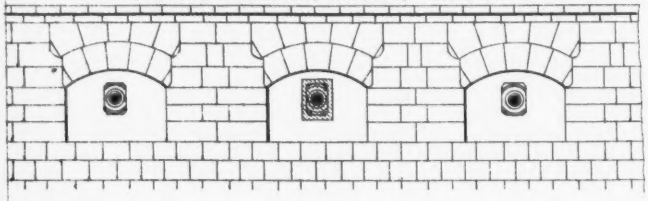
In Table I annexed, will be found the chances against striking such a rectangular vertical target from a steady platform with various natures of guns, at various known ranges, as calculated from the series of rounds fired for range and accuracy at Shoeburyness.

From the table we see that the most dangerous fire is from the ten-inch gun with battering charges at short range; and that high angle fire at all ranges is extremely ineffective, the chances ranging from 388 to 1 against striking such a target at a range of 1,037 yards, up to 7,816 to 1 at a range of 4,676 yards.

But, on board ship, even though the range be known, the unavoidable motion will cause a certain error of elevation, and consequently the chance of striking, is not ever likely to be so great as above described. In almost the only experiment with heavy ordnance bearing on the subject, the attack by the "Hotspur" upon the "Glatton," at Portland, the mean vertical deviation under most favourable circumstances could not be taken as much less than three feet at 200 yards; this corresponds to a mean difference of elevation of plus or minus a quarter of a degree. If the mean differences of range in Table I are corrected accordingly, the results shown in Table II will be obtained, and will, I think, represent as accurately as in the present state of our knowledge it is possible to do, the greatest effect to be obtained, under favourable circumstances, from guns mounted on board ship.

It is clear that small differences of elevation, with a given range, produce much less effect on firing at a high elevation and low velocity, than on firing with a low elevation and high velocity; and, accordingly, we find that the chances against striking a vertical target 3′ 7″ × 5′ 0″ with the eight-inch howitzer at 1,037 yards range, are only increased from

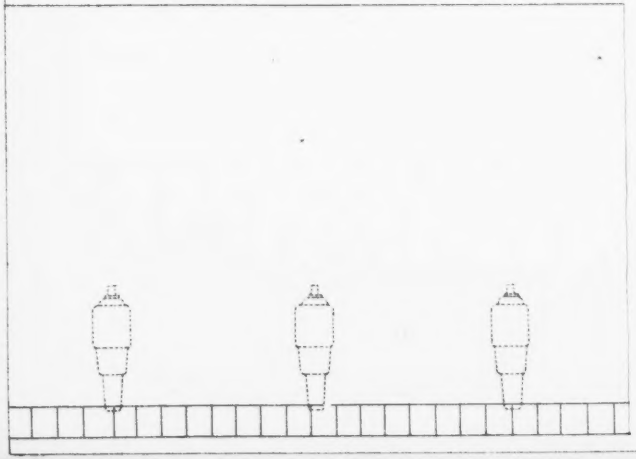
ELEVATION OF A CASEMATED BATTERY OF 11" GUNS
SHEWING A VERTICAL TARGET OF 3.7 x 5.0



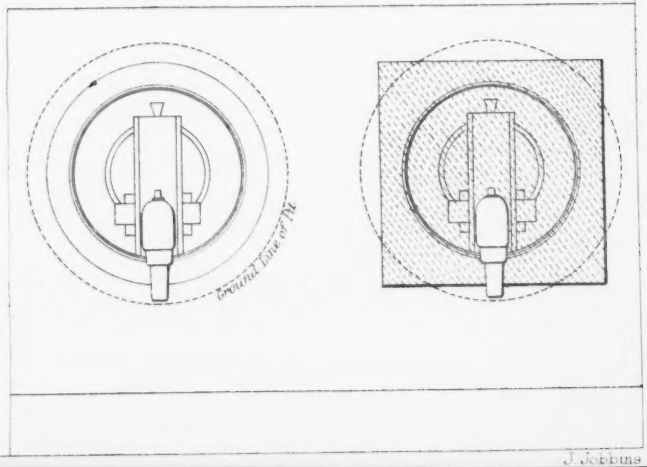
ELEVATION OF OPEN BATTERY
OF
9" GUNS ON MONCRIEFF CARRIAGES.

Scale 20 Feet = 1 Inch.

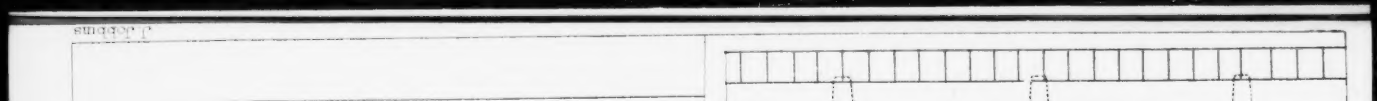
PLAN OF CASEMATED BATTERY



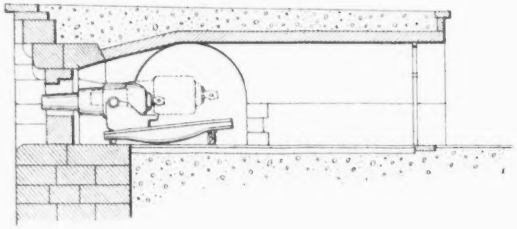
PLAN OF OPEN BATTERY
SHEWING A HORIZONTAL TARGET OF 27Ft x 27Ft



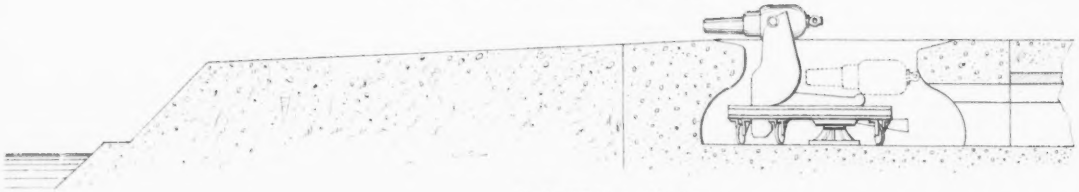
J. Jobbins



SECTION OF A CASEMATED BATTERY OF 11 GUNS



SECTION OF OPEN BATTERY
OF
9" GUNS ON MONCRIEFF CARRIAGES



Scale 20 Feet = 1 Inch

J. Johnms

388 to 1 up to 480 to 1, and at 4,676 yards range from 7,816 to 1 up to 9,730 to 1; whilst the chances against striking with the ten-inch gun are raised at 1,750 yards range from 6·3 to 1 up to 48·3 to 1, and at 2,490 yards range from 10·7 to 1 up to 94·7 to 1.

Still, however, the danger from battering charges is so much the greater, that we may reasonably conclude that subjection to such a fire will be the most trying ordeal to which a shield can be put; and that the plan of attack will be, as previously stated, for the armoured fleet to take up a position as close as possible to the works, and pour in a heavy fire of Palliser projectiles with battering charges.

The gun-boats attached to the fleet would no doubt keep up a shell fire, at a safe range, to disturb as much as possible, by smoke and splinters, the service of the guns in battery; but their chances of doing injury to the men working the guns, or to the guns themselves, are very small; and the effective result of the attack on the works will be almost entirely confined to the projectiles entering a port or striking close to one. It may be said that other parts of a shield will be penetrated, but there is certainly now no difficulty in making every part equally strong, and, whatever may be advanced to the contrary, I am convinced that all the shields yet made in this country, for exposed positions, are totally impervious to any battering which they could receive in action, with the exception of the ports, and of a six-inch margin round them.

The remainder of the front of a work which is not near a gun, and therefore not limited in thickness, can readily and cheaply be made of any strength thought necessary.

Guns in casemate, even when in action, are protected when in the loading position from any fire except in the direction to which they are pointing, and the mantlets fitted up in all casemates will, it is believed, give complete immunity from all splinters inside.

Next, in the case of a barbette battery made of earth or concrete, a comparison may be arrived at as follows:—

Neglecting the vertical target presented, the size of which is a disputed point, an emplacement for a nine-inch gun, *en barbette*, may be considered to present a horizontal target of twenty-seven feet by twenty-seven: these are very nearly the dimensions at the ground level of the emplacement for a nine-inch gun mounted on Major Moncrieff's system at Shoeburyness; and, for high angle fire from any direction, will give, approximately, the dangerous area exposed. (See Plates xxxi, xxxii.) For direct fire the size of target is more difficult to arrive at, as a shot descending at a small angle behind the crest of the pit would not have much effect; but, on the other hand, a shot striking the parapet at some distance from the crest will be dangerous; and, on the whole, it appears fair to consider the horizontal target, in this case also, as equal to the ground area of twenty-seven feet by twenty-seven.

By a similar reference to that already made to the results of rounds fired for range and accuracy, in Table III, it will be seen that, from a steady platform, the chances against the fire from the eight-inch howitzer striking a horizontal target twenty-seven feet by twenty-seven, are from 10 to 1 at 1,037 yards range, up to 139 to 1 at 4,676

yards range, whilst with direct fire the greatest danger is from the ten-inch gun at 2,490 yards range, when the chances against striking are 4·7 to 1.

But, allowing as before for a mean error of elevation of $\frac{1}{4}°$, as in Table IV, the probabilities become reversed; for whilst the chances against striking with direct fire reach 46·5 to 1 with the ten-inch gun at 2,490 yards, the chances with the eight-inch howitzer are only increased to 12·6 to 1 at 1,037 yards, 32·5 to 1 at 2,671 yards, and 174 to 1 at 4,676 yards.

From these results it is plain that the greatest effect against open batteries will be obtained by a high angle shell fire, and that very good results can be obtained at long ranges. Taking therefore into consideration the much less chance of injury to vessels from the fire of a fort, if they are kept as far off as possible, consistently with their own fire being effective, and end on, as they probably can be for working howitzers; we may conclude that what is to be feared in an open battery is the fire of shells projected at a high angle of elevation such as 40°, from ranges of say 2,000 to 4,000 yards.

Much has been said as to the evil effect of ports in limiting the training of guns firing through them, but in any case similar to that under consideration it does not appear that guns require more than a moderate training, and it has, I think, been entirely overlooked that guns in casemates are completely protected until brought into action; it is impossible to give any equivalent protection in an open battery; something, but not much, can be done by raising the merlons, but I should regard it as a positive evil to give a gun more training than was absolutely necessary, having regard to all the conditions of the case.

In comparisons which have been made between an emplacement for a nine-inch gun on Major Moncrieff's system and an open battery shield, it should be remembered that no such thing as an open battery shield, in the strict sense of the word, exists or is likely to exist in the British possessions; all shields which are not casemated are prepared for the reception of overhead cover for the men and gun, and many are furnished with it already. It would take but a short time to completely cover the whole number, and the sole reason why this has not been done already is, that it is far preferable to keep the material for the covering, consisting in great part of timber, in store, rather than to let it decay *in situ*.

The protection of these so-called open battery shields is quite as good, when in good order, against a short bombardment, as that afforded by a casemate; and out of a total number of 397 guns in England, now protected or authorised to be protected by armour, the number behind such shields is 18.

As regards the cost of the two systems, when casemates are employed, it will be found that many more heavy guns can be mounted upon the same foundations, than by the use of open batteries; and the extremely variable cost of foundations in different sites, therefore, prevents any good comparative estimate being made between the cost per gun of a casemated work and of an open battery.

An open battery fitted with shields, however, and one adapted for

Major Moncrieff's carriages, would require substantially the same foundations; but a nine-inch gun-pit cannot fairly be compared with a shield which has been found by direct experiment to be completely proof against the 25-ton gun, and as far as can be known in the absence of actual trial, is believed to be proof against the 35-ton gun at any range.

Surely, the comparison should rather be made with a shield only capable of resisting nine-inch guns or their equivalents, for it is not to be supposed that nine-inch guns will usually be employed on shore against anything heavier at sea.

If this is admitted, the comparison will stand as follows, neglecting open battery shields without overhead cover as incomplete:—

	£
Moncrieff's 9″ pit, with expense magazine, say	1,070
Moncrieff's 9″ carriage, pattern II, say ..	1,340
Total	£2,410

And—

Open battery emplacement, with expense magazine, shield with 10″ armour and overhead cover, say	2,200
Service 9″ casemate carriage and platform, say	350
Total	£2,550

But it will probably be allowed that it is extremely unlikely that ships carrying nine-inch guns, or guns equivalent to them, will ever be sent to attack a modern fortified place; and it may be assumed that the least gun which will be employed will be equivalent to the ten-inch 18-ton gun, and will require 18-ton guns to be opposed to it.

In this case, assuming that the Moncrieff system can be successfully applied to guns of 18 tons weight; in the absence of exact estimates, it may fairly be considered that the weight and cost of Major Moncrieff's carriage will be increased in proportion to the weight of the gun, that is, by 50 per cent. for a ten-inch as compared with a nine-inch gun carriage; the comparison will then be as follows, if the Moncrieff pit be assumed to be increased by 10 per cent. in cost., to receive a 10-inch gun.

	£
9″ gun-pit, with 10 per cent. added, say ..	1,180
9″ gun-carriage, with 50 per cent. added, say ..	2,010
Total for a ten-inch Moncrieff gun	£3,190

And—

Open battery, &c., shield, with 15″ armour to resist twelve-inch guns, and overhead cover, say.	2,650
10″ casemate carriage and platform ..	490
Total for ten-inch gun behind shield ..	£3,140

If, however, instead of thinking only of the first cost to be incurred in fortifying a position, we pay some little attention to the probable requirements of the immediate future, a far more important consideration arises as regards the economy of the two systems. For armaments must change, and guns, such as the nine-inch or ten-inch, which at one time were the heaviest which could be made, and are now sufficient to meet the vessels of the day, may, ere long, be found inadequate to the task required of them.

Vessels plated with thicker armour are constructed, and then heavier guns follow as a natural consequence, and must replace those already mounted on the works. The works themselves can generally be adapted to their new armament with but trifling expense, but new carriages must obviously be provided, and in any system of which the carriage forms the most expensive part, every change of armament must prove enormously costly.

It may be said that in such a case the old armament could be used elsewhere, and no doubt the guns could and would be applied to different purposes, naval or otherwise; but if Major Moncrieff's system were generally adopted for coast defence, there would be no scope for the employment of the carriages for the heavier natures of ordnance, except in the sea batteries for which they were originally intended. The number of sea batteries is limited and practically complete, and land defences do not require such heavy guns. The same shield will, however, without any alteration, allow any nature of gun from the seven-inch to the ten-inch to be worked behind it, and with slight alterations, will permit the use of eleven-inch, twelve-inch, or even heavier guns.

In considering economy, however, in such structures, as well as efficiency, it appears to me that too much stress has generally been laid upon reducing the cost of a single gun as much as possible; and that it would be a safer plan to ascertain first, what sum is required to give proper efficiency to a gun, and then to use as many, well protected, as could be obtained with the money available for the defence of a place, rather than to crowd in a large number upon a cheap, imperfect system.

Such would require large garrisons, of necessarily untrained men, would present more liability to the danger of being overcome piecemeal, and would afford more useful material to an enemy in the event of being taken.

The Moncrieff system is as much in its infancy now, as iron plates were ten years ago, when the cost of protecting a gun with iron, against the artillery of the day, was from £300 to £500; but the improvements in artillery have increased the weight of shot ten-fold, and the cost of protection fully four-fold; and if the Moncrieff system, or any analogous one were largely adopted, so as to make it worth while to devote special attention to the means of attacking it, there is, I think, no doubt, but that the cost of protection required would as largely increase.

The development of curved fire, which would appear to be the most likely method of attack, would surely not be such a difficult task as the development of armour piercing projectiles.

It is almost certain that no material improvements will be made in the shape and material of the latter; and it appears probable that the limits of weight and velocity are already nearly reached, on account of the difficulty of finding any material to withstand the strains produced on the inner tubes of heavy guns by the enormous charges even now found requisite.

We may, therefore, venture to hope that comparatively little if any further expenditure will be necessary to maintain the present invulnerability of our iron coast defences.

With earth or concrete parapets, however, the case is far different, and it is impossible, at present, to assign a practical limit to the dimensions and to the accuracy of fire of heavy shells, or to the destructive effects of the explosives they may carry.

A comparison of the two methods of defence will, I think, show that the best chance of success, in the example of a fortified position which I have selected, is offered by the use of guns properly protected by casemates.

This example might, if time permitted, be indefinitely varied; but, whether for a strong position attacked by an enemy's fleet, or for a small commercial harbour defended by a single battery; if the cases be worked out in detail, it will be found that the same considerations apply: that the value of torpedoes is to oblige ships to take up a certain definite position where they will be exposed to the fire of heavy guns: that, therefore, the training of the guns may be limited: and that the offensive power of a fleet consists in a shower of projectiles and fragments of projectiles of all shapes and sizes, and coming from all directions, from which overhead as well as front cover is absolutely essential.

The tendency at sea, with considerably more actual experience than on shore, has been to increase the weight, to diminish the number, and to increase the protection, both overhead and direct, of guns on board ship, and though the details are different, the general conditions are the same; and whatever system is adopted for ships must, to a great extent, regulate the means required successfully to oppose them.

I entirely fail to see, that, in fortifying a position such as that described, or any other which I can conceive, there is anything in Major Moncrieff's invention which is likely to overturn the recognized principles of fortification. The works necessary to receive a gun mounted on a Moncrieff carriage do not appear to differ, in any material respect, from those required for any ordinary gun mounted *en barbette*; and the magazine arrangements, and all accessories, must surely remain the same. The positions of works must be regulated by the effective range of the guns employed, and in what respect the fact of their recoiling under cover for loading can affect their range or accuracy is hard to be understood; whilst Major Moncrieff's favourite system of single gun-pits, spread out along a line of coast would, I think, develop, in practice, into something very much like the familiar old Martello towers, possibly somewhat increased in dimensions.

In, conclusion, it would appear that many arguments can be advanced, on both sides of the question, and the object of this paper is

simply to show that there is a great deal to be said on a side which is not generally heard; but the subject is, I think, of such a complicated nature, that comparisons, by words and arguments, will always remain unsatisfactory.

Persons taking one side will lay great stress on, and form their opinions from, matters which appear trivial to those who hold a different view; it is much to be hoped that the direct experiments, shortly to be undertaken, will solve some of the doubtful points indicated.

Even if it be impossible to rehearse exactly what may be expected to occur in an action, yet many points can be cleared up, such as to determine the angle at which shells will enter concrete at various velocities, to see the damage likely to be caused by splinters to a piece of machinery, such as one of Major Moncrieff's carriages; and to ascertain many other facts which have a most important bearing upon the general question.

Such crucial trials were made, upon experimental gun-shields and casemates, before those now defending our naval dockyards were constructed, and if the Moncrieff carriage passes as well through a similar ordeal, I, for one, shall be much surprised.

TABLE I.—Of the Chances against striking a Vertical Target, size 3′ 7″ × 5′ 0″ at various ranges, from a steady platform.

Range, in yards.	Gun.	Charge. lbs.	Projectile.	Angle of Elevation.	Angle of Descent.	Number of rounds fired.	Mean difference of		Chances against striking.
							Range in yards.	Deflection in yards.	
1037	8″ howitzer	2	Common shell	40° 18′	43° 6′	3	14·	6·	388· to 1
1563	Do.	3	Do.	40° 12′	44° 25′	3	18·	5·	451· to 1
1750	10″ gun	60 R. L. G.	Palliser	3° 0′	3° 36′	20	20·8	1·05	6·3 to 1
1789	9″ gun	43 R. L. G.	Do.	3° 10′	3° 54′	10	81·1	4·4	103· to 1
2490	10″ gun	60 R. L. G.	Do.	4° 42′	5° 24′	5	16·	1·5	10·7 to 1
2633	9″ gun	43 R. L. G.	Do.	5° 7′	6° 54′	8	79·6	5·6	261· to 1
2658	11″ gun	85 P.	Do.	5° 11′	5° 50′	10	21·2	2·4	24·9 to 1
2671	8″ howitzer	5	Common shell	40° 8′	47° 20′	10	34·	6·	932· to 1
4283	Do.	8	Do.	40° 5′	51° 38′	18	45·	10·4	3068· to 1
4676	Do.	10	Do.	40′ 4	53° 6′	20	63·	18·	7816· to 1

TABLE II.—Of the Chances against striking a Vertical Target, size 3′ 7″ × 5′ 0″ at various ranges, with a mean error of elevation of ± ¼°.

Range, in yards.	Gun.	Charge. lbs.	Projectile.	Angle of Elevation.	Angle of Descent.	Number of rounds fired.	Mean difference of		Chances against striking.
							Range in yards.	Deflection in yards.	
1037	8″ howitzer	2	Common shell	40° 18′	43° 6′	3	17·3	6·	480· to 1
1563	Do.	3	Do.	40° 12′	44° 25′	3	23·1	5·	585· to 1
1750	10″ gun	60 R. L. G.	Palliser	3° 0′	3° 36′	20	145·8	1·05	48·3 to 1
1789	9″ gun	43 R. L. G.	Do.	3° 10′	3° 54′	10	196·5	4·4	252· to 1
2490	10″ gun	60 R. L. G.	Do.	4° 42′	5° 24′	5	131·4	1·5	94·7 to 1
2633	9″ gun	43 R. L. G.	Do.	5° 7′	6° 54′	8	173·3	5·6	589· to 1
2658	11″ gun	85 P.	Do.	5° 11′	5° 50′	10	136·6	2·4	165· to 1
2671	8″ howitzer	5	Common shell	40° 8′	47° 20′	10	42·8	6·	1198· to 1
4283	Do.	8	Do.	40° 5′	51° ′38	18	59·	10·4	3900· to 1
4676	Do.	10	Do.	40° 4′	53° 6′	20	79·	18·	9730· to 1

TABLE III.—Of the Chances against striking a Horizontal Target, size 27′ × 27′ at various ranges, from a steady

TABLE III.—Of the Chances against striking a Horizontal Target, size 27′ × 27′ at various ranges from a steady platform.

Range, in yards.	Gun.	Charge. lbs.	Projectile.	Angle of Elevation.	Angle of Descent.	Number of rounds fired.	Mean difference of		Chances against striking.
							Range in yards.	Deflection in yards.	
1037	8″ howitzer	2	Common shell	40° 18′	43° 6′	3	14·	6·	10· to 1
1563	Do.	3	Do.	40° 12′	44° 25′	3	18·	5·	11· to 1
1750	10″ gun	60 R. L. G.	Palliser	3° 0′	3° 36′	20	20·8	1·05	6·3 to 1
1789	9″ gun	43 R. L. G.	Do.	3° 10′	3° 54′	10	81·8	4·4	45· to 1
2490	10″ gun	60 R. L. G.	Do.	4° 42′	5° 24′	5	16·	1·5	4·7 to 1
2633	9″ gun	43 R. L. G.	Do.	5° 7′	6° 54′	8	79·6	5·6	46·5 to 1
2658	11″ gun	85 P.	Do.	5° 11′	5° 50′	10	21·2	2·4	7·6 to 1
2671	8″ howitzer	5	Common shell	40° 8′	47° 20′	10	34·	6·	25·6 to 1
4283	Do.	8	Do.	40° 5′	51° 38′	18	45·	10·4	57·7 to 1
4676	Do.	10	Do.	40° 4′	53° 6′	20	63·	18·	139· to 1

TABLE IV.—Of the Chances against striking a Horizontal Target, size 27′ × 27′ at various ranges with a mean error of elevation of ± ¼°.

Range, in yards.	Gun.	Charge. lbs.	Projectile.	Angle of Elevation.	Angle of Descent.	Number of rounds fired.	Mean difference of		Chances against striking.
							Range in yards.	Deflection in yards.	
1037	8″ howitzer	2	Common shell	40° 18′	43° 6′	3	17·3	6	12·6 to 1
1563	Do.	3	Do.	40° 12′	44° 23′	3	23·1	5	14·5 to 1
1750	10″ gun	60 R. L. G.	Palliser	3° 0′	3° 36′	20	145·8	1·05	50· to 1
1789	9″ gun	43 R. L. G.	Do.	3° 10′	3° 54′	10	196·5	4·4	116· to 1
2490	10″ gun	60 R. L. G.	Do.	4° 42′	5° 21′	5	131·4	1·5	46·5 to 1
2633	9″ gun	43 R. L. G.	Do.	5° 7′	6° 54′	8	173·3	5·6	123· to 1
2658	11″ gun	85 P.	Do.	5′ 11°	5° 50′	10	136·6	2·4	51·3 to 1
2671	8″ howitzer	5	Common shell	40° 8′	47° 20′	10	42·8	6	32·5 to 1
4283	Do.	8	Do.	40° 5′	51° 38′	18	59	10·4	75·6 to 1
4676	Do.	10	Do.	40° 4′	53° 6°	20	79	18	174· to 1

The CHAIRMAN: Has any gentleman any observations to make on the paper we have heard? I should like to ask a question about your tables, Nos. I and II. Is II the limit to I? You have got the 8-inch howitzer, 1,037 yards in both, and the chances against striking in the one case which are constant, is 388 to 1, and in the other, 480 to 1. Is that supposed to be the limit, the maximum and minimum?

Lieutenant ENGLISH: No. I Table is firing from a steady platform where the elevation is exact. No. II is firing as they might do at sea with an error of elevation of a quarter of a degree.

The CHAIRMAN: How is that got?

Lieutenant ENGLISH: It is assumed as the amount of error of elevation, but the mean difference of range can be directly calculated from it.

Captain GOODENOUGH, R.N.: Is the number of rounds from actual experiment from which those figures are deduced?

Lieutenant ENGLISH: The whole thing is from actual experiment with the exception of the last column, and that is calculated from the official book, Captain Noble's Second Report on Ballistic Experiments. The formula for the calculation will be found at page 174.

Vice-Admiral Sir F. NICOLSON, Bart.: You have assumed that the motion of the ship only gives an elevation of a quarter of a degree.

Lieutenant ENGLISH: I have assumed it from the only experiment which has been carried on, bearing on the subject, the attack of the "Hotspur" on the "Glatton," where the mean difference I do not think could be taken as less than 3 feet at 200 yards, which corresponds almost exactly to a quarter of a degree. (Sir F. NICOLSON: The mean error?) The mean error.

Commander W. DAWSON, R.N.: As a naval man, I would venture to observe that Lieutenant English has fallen into an error as to the cause of that inaccuracy of fire witnessed whilst firing seven shot from the "Hotspur" at the "Glatton." I speak of this irregularity of flight not after the event, but as an incident of imperfect rotation and deficient centring previously known to artillerists. I happened to have a conversation with a Royal Artillery Officer of high rank and great experience, before the practice took place, who told me what his Shoeburyness experience taught him to expect from 600lbs. shot fired at ranges of 200 to 400 yards, viz., that they would rotate so imperfectly as to strike as much as two feet from the bull's eye, above, below, right or left of it. The seven shot fired at Portland did what this superior artillery officer foretold as likely to occur, even had the platform been on *terra firma*. Every naval gunner knows that a small roll of one or two degrees has no injurious effect upon the accuracy of aim, but, if it be a uniform motion, rather facilitates the process of aiming. If the firing were being conducted in the open sea with heavy rolling motion, instead of in a river or close to the harbour, I quite agree with the lecturer that the question of a degree of elevation is likely to be a small error for naval gunners to make, especially as the sights are very badly placed, and at present seamen are very badly trained as to eye exercise.

To pass to the general question, I confess I am a great deal reassured by what has fallen from Lieutenant English to night,—reassured, because, if I understand him aright, the Moncrieff system is not likely to be generally adopted. I say I am reassured on that ground because I confess that I did feel, as a naval man, rather reluctant that Major Moncrieff's system should succeed; and for this reason, that if our navy performs its duty to this country, no gun mounted on a battery on our shores could ever have an opportunity of firing at an enemy. But it would necessarily follow if Moncrieff's system succeeds in this country, that foreigners would employ it to defend their shores against British ships; and naval men have to judge how they would like to be opposed by guns popped up from holes in the ground which offered our seamen no target to aim at. This absence of visibility in a battery, comes home much more forcibly to naval men than to our military brethren. Military men are aware that there is at Gibraltar a battery called the "Snake in the grass," but perhaps they have not had the opportunities of studying that battery from a distance which are accorded to naval men. I am quite sure any naval man who has studied the batteries at Gibraltar, from the deck of his ship, would say that the battery he would least like to have to deal with offensively, is that very "Snake in the grass." A similar battery was pointed out to me the other day at Portland, on the side of

the hill which offers in the same way hardly any target at which naval gunners could take aim. Looking at that battery and at the one at Gibraltar, it has always struck me that the least formidable work to ships is a casemate, and the most formidable is that in which a gun comes up from a pit, and pops at you and then disappears, leaving no visible covering works to be destroyed. Having said so much as to the general principle of visibility and invisibility of batteries, I think the particular mode by which this invisibility is to be obtained and its cost in mechanical and engineering difficulties, is open to consideration. When I saw the 9-inch gun on Moncrieff's carriage fired at Shoeburyness last year, the machinery appeared to me rather more complicated and delicate than I had anticipated; and two questions arose in my mind, questions which I hope some military gentleman will answer, for I have heard them asked by various people. One question was this: Supposing the navy neglects to do its duty in blockading foes in their own harbours, and that a hostile fleet attacks our shores, and supposing that this disaster takes place fifty years hence, in what state would that gun carriage and its machinery be at outlying batteries say 20 miles to the westward of Pembroke, out of sight and out of mind—in what state would it be fifty years hence, to receive an enemy? The second question was, supposing a shot struck the crest of the parapet, and some stone, brick, or other material was thrown down amongst the machinery whilst the gun was in the act of recoiling on firing, would the machinery be seriously damaged and rendered incapable of further use? Those are the only two difficulties that strike me with reference to the mechanical part of the subject. I confess, when I come here to-night, and see by the diagram that Moncrieff's gun carriage is to be employed in an open battery with an elevated parapet instead of in a pit, it alters my argument in some degree. Still I can quite imagine that if an addition was made of a grass slope in front of the battery, with sunken defences and a grass bank or rising ground behind the gun a little way back, that the battery and its gun could be made utterly invisible to seamen gunners, I should certainly dislike, very much indeed, to have such an invisible battery armed with such hidden guns opposite to my ship; whereas guns placed in a casemate are respectable objects to hit, for there is something tangible to see, and something which if British guns are worth anything, and have not "decidedly the lowest velocities" and worst penetration, they will be very likely to pass through and destroy. As to the gun-shield, I confess I am ignorant of its constructive details as well as of its appearance when in position. There is no diagram of such a battery before us, and in the absence of such information I am unable to form any opinion as to its relative merits in comparison with the casemate and with the gun-pit, from a naval point of view.

Major MONCRIEFF, F.R.S.: Mr. Chairman and Gentlemen, I hope that this meeting does not expect that I should without notice meet the arguments, and go into all the details of the tabular statements that have been brought forward to-night. Until I came here I did not know what form this lecture was to assume, and I must say that I have been somewhat surprised at the tenor of Lieutenant English's observations. I know his position as an Officer of the Works Department, and I presume the case he has brought forward, represents to a certain extent the views of that department. I am also now made aware, from the statements of Mr. English, that these views are adverse to mine. The essence of his remarks may be recognised in this sentence:—"I entirely fail to see that there is anything in Major Moncrieff's invention which is "likely to overturn the recognised principles of fortification." "The works neces-"sary to receive a gun mounted on a Moncrieff carriage do not appear to differ in "any material respect from those required for any ordinary gun mounted *en bar-*"*bette*, and the magazine arrangements and all accessories must surely remain the "same." If that is the view of Mr. English and of the Works Department on the Moncrieff system, it is evidently quite different from mine. I believe that the system is capable of introducing very important changes in fortification, not only in that part to which Mr. English has confined his observations bearing on coast defence and in relation to heavy guns, but in many other developments. The question of coast defence does not only consist in the application of iron-punching guns, but also in the dispositions for meeting the landing parties which fleets could dispose of. No ordinary batteries could withstand the fire of the heavy artillery of ships without being completely silenced, and I am not aware that any plan but mine has been yet

advanced for meeting this contingency, except the expensive iron works with which Mr. English has been so much concerned. There are many places on the coast, including the neighbourhood of batteries of the first class, which, while exposed to ship's artillery, must also be defended against land attack, for instance, the flanks and rear of important batteries, the gorges of which in existing batteries are not particularly strong in some cases. That is a part of coast defence altogether independent of very heavy land guns. I object now, however, to take up this question, and argue each point *seriatim* with Lieutenant English, because I am not a speaker, and I cannot thus convey my ideas at a disadvantage. All I have to say is, that there are many statements advanced in this paper, which I can meet and refute. I would prefer an opportunity of doing so in a form that would be more satisfactory to the meeting. A question was asked by Captain Dawson about the state in which one of my gun-carriages would be fifty years hence in comparison with another gun-carriage. That is a question which I am able to answer. I believe that any practical engineer who examines my gun-carriages would see that they have as good, if not a better chance, of being in fit condition fifty years hence as any other gun-carriages, and for this reason, that they do not depend upon any nice adjustment or gearing for their proper action. I allow that they appear to be complicated, the more so from their novelty; but that complicated appearance is given by the gearing required for lowering the gun, and for drill purposes. Those parts of the carriage which are required for fighting purposes are very simple and not likely to get out of order, and I should say the carriages will compare very favourably indeed in this respect with others used for guns of the same calibre. I would also like to protest against assumptions by Lieutenant English, that because my system has as yet only been carried as far as a 12-ton gun, that it cannot, therefore, be carried further than an 18-ton gun. I take this opportunity of publicly stating that, when the time arrives for doing so, I am prepared to mount the very heaviest artillery that can be produced. I shall be ready, when that time arrives, to mount 50- or 100-ton guns if necessary. It is not my fault that so little progress has been made, and I object to that delay being used as an argument against further progress. I would remark that I am kept in ignorance of the way in which the Works Department intend to apply my system. I have not been consulted in the manner which I had expected regarding the Moncrieff works; but, on the other hand, I see clearly from the exposition that we have had to-night, that the Works Department, judging by that exposition, do not know what my system is capable of, nor correctly estimate its importance. I think it would be better if we both knew a little more of each other's views regarding these matters; it would be better for me, and it would be better for the public service. Had such been done, probably some of the statements which are embodied in this paper would not have been publicly brought forward.

Captain BURGESS: I should like to know whether any experiment has been made to show how many shot and shell would fall into a gun-pit from a 9-inch gun at a certain range?

The CHAIRMAN: Those tables are meant to meet that.

Captain SELWYN: Are your tables made from actual experiment, or from assumption?

Lieutenant ENGLISH: Except the last column, as I have already stated, they are the result of actual experiment.

Captain SELWYN: I have been waiting to hear some one on the military side of the question; but as the Lecturer has principally given us an exposition of presumed attack by seamen on batteries, I think seamen may very fairly have a very large word to say, and I start by saying, that any seaman of the present day who attempted to attack in the manner shown by the Lecturer probably ought to be tried by a court-martial and dismissed the Service. In the first place, there are natural advantages for a fleet as to position which are not in themselves to be ignored, but I say distinctly, as I have said once or twice before, that no attack by fleets is ever to be expected round our island at points which are carefully fortified. The great art is to spread your defences as much as possible, and not to let your enemy know where they are. Unfortunately, the publicity which is given to everything renders it nearly impossible to fulfil the last condition, but luckily the newspaper eyes,

although almost ubiquitous, are not quite so, and occasionally a nice little battery on our coasts gets neglected, which would receive an enemy very unpleasantly if he came near it. That battery will be infinitely more formidable, notwithstanding all that the advocates of casemates may say, in proportion as it covers a larger area of fire. It is no use to tell me that when you get up against a battery you would be affected by a very heavy fire. If I can find one single spot on the whole water horizon where I can place a ship and she cannot be struck by a gun in the battery, that is precisely the place I will go to. If you will give me nice little islands, I will put gun-boats behind those islands, not carrying 9-inch howitzers or contrivances of that sort, but carrying the very heaviest gun that can be put afloat. There is no difficulty; people have said there was, or supposed that there was; but no man that knows anything of the sea, thinks that there is any difficulty in carrying heavy guns in a gunboat. We carry 18-ton guns now, and we will carry 30- or 40-ton guns. But there has been a manifest reluctance to give to the Navy anything like what they would like to have, either in the way of attack or defence; we are always supposed to attack where we would not go; we are always required to defend with guns that we do not approve of. As long as that is the view that artillerists on shore take, we are at a disadvantage, but I trust the expedients in which seamen have generally shown themselves fertile, will still enable them, when they have to attack a foreign enemy, to nullify those disadvantages. As for torpedoes they are an enemy which hitherto, with our present construction of ships, we have not seen any way of avoiding; but we know perfectly well, with steam at our command and by the sacrifice of smaller vessels, we can sweep a channel clear of torpedoes. At night we can cut off, without much difficulty, all your communications with your torpedoes through electric wires, and you shall never know that we are doing it except by the disconnection with your galvanic battery. All these things are details which will be carried out by seamen when the necessity for them arrives. But when we are asked to believe that something we cannot see, spread out like a table-cloth on the ground, at any range between 500 yards and 3,000, is a better mark to aim at, and that we have more chances of hitting *it*, than a target made up of a casemate,—for all the casemates we have yet built are made on the assumption that the gun-power would not go any further, that there would be no advance in guns, or that granite would continue to resist, in exactly the same proportion, if you double the thickness of armour in the casemate; that accuracy of fire would not be increased, and that we should always aim at ports,—we doubt the justice of the conclusion. Now I think Lieutenant English, by his own table, has shown that the maddest thing on earth would be to try to fire at gun-boats. I should be very glad indeed to find an enemy in a battery with a bright idea that he would hit a man in a port. If he fired at the port, the chances are he would never hit the ship. His error would be quite sufficient to carry him quite clear of the gun, I am quite certain, and probably he would never hit the very vulnerable portion which is the part we do fear for in modern ironclads, namely, the deck. Our vulnerable part in ironclads is shown when we advance end-on, and a length of some 600 feet is exposed as a deck to curved fire, for that shot which strikes us somewhere near the forecastle goes out through the stern, and very probably takes off the rudder. That is where our danger lies, and we do not intend to encounter it if we know how to guard against it, but when I am asked to believe, first of all, that that is a fair representation of a Moncrieff gun-pit, I utterly deny it. The whole value of the Moncrieff battery is its invisibility, but if you are to show me something on a bank like *that*, (referring to the drawing of a raised (Moncrieff) battery,) which I can see for many miles, I shall probably fire at that, and not at the puff of smoke. I have seen a good deal of firing at puffs of smoke, and my remembrance is, that they were always fired at when they were some 200 or 300 yards to leeward of the gun that fired. The artilleryman saw the puff of smoke, but he did not exactly calculate where it came from, and he fired at what he could see. It is a most unsatisfactory way of firing. If you can put gun-boats at long ranges and a battery is firing at them, I am quite certain you will spend every shot in the battery before you will demolish five guns. The chances are 1,000 to 1 against your hitting. I suppose I may say after that table, 7,816 to 1, at the long range. Well, now, I ask you, is it reasonable to suppose that anybody will throw away shot from a battery

to try to hit a gunboat which everytime will hit you. Your battery is much bigger than the gunboat; your battery is very visible, but the gunboat, if behind one of these islands, is not visible at all. And more than that, you do not know when you have hit. If I was taking that river, as it is shown there, there is, I think, fully one-third of the water shown there on which not one single gun can bear—on which any person could hit a vessel. That is where I should place my gunboats, behind those islands. (Lieutenant ENGLISH: Those islands are simply shoals of less than 18 feet deep at low water.) They look like islands—shoals and islands, such as would occur in any channel we are acquainted with. (Colonel JERVOIS: You cannot hide yourself behind shoals.) It depends on the tide. If I knew there were shoals at low water, I should go there at low water, and I should go away at high. But you must recollect that in this whole question we are asked to believe that a battery set up to be fired at on the shore, with casemates and granite, is less vulnerable than earth of unknown thickness, and where there is no target whatever to aim at. If you take a Moncrieff gun-pit and transform it into an elevated battery, and then heap earth round that battery, and call that a Moncrieff gun-pit, I should quite agree, first, that you have not understood the Moncrieff system at all, and secondly, that you have made a very easily attackable battery. But that, I presume, is what no talented engineer would do. Now take the question of attack. I ask you to believe that this point is the only one which we can attack, and that I want to attack that with a fleet, as all fleets do now, carrying troops. I do not think anybody in his senses would proceed in any other way than that in which armies proceed when they are passing a defile. You would crown the heights, you would land and carry the batteries in reverse, protected by the fire of the fleets; and if they are casemated batteries, like that, they are much more easily attacked than the Moncrieff gun-pit, which can traverse its guns round to fire on attacking parties on the land side. These casemate batteries cannot do that. Is it or is it not an advantage to have a turret on board a ship with a theoretical all-round fire? and if so, why should it be a disadvantage to have a practical all-round fire on shore? Again, compare the expense. It is assumed that no foundations will do other than those which suffice to support the weight of a great granite battery with casemated shields of unknown thickness, for we have not yet arrived at the thickness which will protect guns; we are asked to believe that these same foundations will be necessary to support the weight of single guns, or numerous guns, if you like to put them in a battery. I cannot conceive it—I cannot understand it in any sort of way. I know in the attack of Charleston it was found sufficient to lay down on a positive swamp a certain amount of fascines with baulks of timber over them, and that on an improvised platform a heavy gun was fought for months with good effect. I say mud is a better sustaining power than water, and that what we can do on water, the weight we can support on water we can certainly support better on mud, and there is no difficulty about doing that without trying to pile down to the bottom, and then to erect a concrete foundation afterwards, which in some cases in our modern batteries has split in two, because it has no solid foundation. That is not engineering. I do not think any such assumptions are of any value in this Institution, they are nothing but assumptions from beginning to end. There is the assumption that there was a swell at the Needles: we will admit that the error was due to the swell, though it is a very curious swell which cannot be detected by a gunner who is pointing his gun. He must know it perfectly well; and if he cannot shoot straight he has not learned the ordinary training of the eye on a man-of-war, which allows for much larger changes than that. We will admit that it was due to the swell, but is that a fair measure of what will occur in a river? Will any man tell me that gun-boats or ironclads coming up the Thames would be subject to the same swell as at the Needles, or that that is a fair thing to take as a basis of assumption for the chances of striking. These are nothing but the broadest assumptions justified by the very slightest experiments. Ballistic experiments do not give you any measure of the error due to firing large guns and mortars with unknown atmospheric changes, with powder of varying densities. More than two or three years since we had a comparison, by Major Alderson, of the difficulties of hitting a horizontal plane, and, according to him, we might have fired all day and never could have landed one single shell in a Moncrieff battery. This was the state of the case

when accurate experiment was made at Shoeburyness. He would have had no difficulty in hitting a casemate every time at the same range. And if you come to carry Lieutenant English's own figures further you will see if this be true of the attack, still the defence has this disadvantage, that while a battery is a large-sized object, and perfectly visible, the gunboat is a very small-sized one, and is not only very imperfectly visible in consequence, but she is also capable of rapidly changing her position, so that a few turns of the screw, which no man at the battery could detect, would at once place the range at fault. I have seen at Gibraltar a detachment of well-practised artillerymen one whole day trying to hit a 12-foot target at 1,200 yards because the target was sweeping about a little in the tide, and they never struck it during the whole day. You imagine what the mobility of a gunboat is in preventing the extreme accuracy which has been calculated as *against* Major Moncrieff's gun-pits in one direction, but in favour of the casemated battery in the other. Then, again, I remark, with the greatest pleasure, that whereas four years ago, for the first time, you were told by Major Moncrieff that there was to be a system by which every harbour would be mapped out so accurately that parties at a considerable distance from the batteries themselves, communicating electrically with those batteries, should be able to direct their fire without being puzzled by the smoke, I am delighted to hear that at last, some of the authorities seem to be alive to the value of the suggestion. That is a modicum of advance. A still greater advance will be made, I have no doubt, when inventors are allowed to have some sort of idea of what is to be done with their own inventions, when they are allowed to give the time and attention which the nation has already paid for to the subject, instead of engaging men who have never shown the slightest power of appreciation of their inventions to do exactly what the inventor told them they ought not to do. This is a very lamentable state of things, and I have no doubt as long as it lasts every invention that can possibly be applied will be shown to be utterly impracticable and totally wrong. The inventor says, "Well, you have given this account, but I am afraid I cannot endorse it at all. I shall be very glad if you will allow me to tell you what I do indorse, and to relieve you from the burdens which you seem to be labouring under;" and I am quite sure from what I have had the pleasure of knowing of Major Moncrieff, that he is, of all other men, the one most ready to give information if asked for, and the most reluctant to force it on where he finds that it is coldly received.

Captain DAWSON: I think Captain Selwyn would like to be corrected as to the question of the "Hotspur's" firing. It was inside the harbour of Portland, and the roll was so exceedingly small, that a brother gunnery Officer reminds me, even if it had been three or four degrees instead of being less than one degree, it would have had no appreciable effect whatever upon the accuracy of the fire.

Major MONCRIEFF: I should like to add one remark. The Lecturer dwelt upon the horizontal exposure of my emplacements, and estimated that exposure at 27 feet square. That is a considerable area; the actual opening is about 20 feet in diameter. I would wish to remind the meeting that my batteries are not the only open batteries. The shield batteries are also open. In Lieutenant English's paper he takes for granted that the shield batteries are covered. It is very true in one sense that they are to be covered. Balks of timber covered with earth and with 6 or 8 feet of concrete in front above the shield, but that cover is not capable of resisting such projectiles as would be delivered against these emplacements by ships of war. Possibly cover of this description instead of being a protection in action would be a source of danger, both with direct and curved fire from heavy guns. At any rate, when so much curved fire has been directed against my pits, I think a little notice should be taken of the exposed horizontal area of shield emplacements. There is no plan exhibited here of a shield emplacement, but if you will examine such plans, I think you will find that, excepting a splinter-proof cover, the horizontal area exposed to the penetration of heavy shot and shell is quite as large, if not larger, than that of the Moncrieff pit.

Colonel JERVOIS, R.E.: I rise to make only one or two short remarks. With reference to Major Moncrieff's supposition, that Lieutenant English is necessarily giving the views of the department to which he belongs, I must observe that that is not the case. Some people belonging to that department may hold those views;

others may not. Lieutenant English comes here in his private capacity, as an Officer representing his own views. I venture, however, to submit that those views deserve full consideration.

The CHAIRMAN: I, for one, shall be very glad to give them consideration. Of course any Officer who speaks in this Institution is not supposed to be giving the opinions of any other people, but his own.

Colonel JERVOIS: I will add—speaking for myself as an individual—that it cannot be supposed that I am opposed to Major Moncrieff's mode of mounting guns; on the contrary I am one who desires to give it the fullest play possible. I have no stronger testimony on this point than that of Major Moncrieff, who, in the most handsome manner, volunteered on a certain occasion to write to the "Times," to say that it was to your humble servant that the introduction of the carriage into the service of this country was mainly due.

Lieutenant ENGLISH: Unless Colonel Jervois had spoken I was prepared to state that of course my views were my own only, and in my own private capacity, and that I did not consider any person hearing me would imagine otherwise. With that preliminary I will meet one or two of the objections to my paper.

Major Moncrieff says his carriage would be as good as any other in fifty years. I have not entered into any of the mechanical questions connected with the carriage, and would rather not give any opinion upon it at all. But I would like to state that I have made no assumption whatever that his system cannot be carried further than the 18-ton gun. For myself, I believe it can be carried to any weight of gun, but that the cost will increase enormously in doing so. I have attempted to show in my paper that with an 18-ton gun, the cost of a gun mounted on the Moncrieff system is more than that of a gun mounted behind a shield, and if the weight gets greater, the discrepancy in cost becomes greater also.

With regard to Captain Selwyn's remarks on these diagrams, that a position like this would not be attacked in that way, because a fleet would not attack points that were carefully fortified, it seems to me if a fleet is to pass through a channel it must pass up the whole length of it, and therefore pass points that are carefully fortified, otherwise it would not fulfil the object set before it. I do not propose to give any opinion on the merits of the 8-inch howitzer; certainly its firing seems to be tolerably good, and it seems to me that if the deck of an ironclad is the most exposed part of it, surely the surface of an open battery is in a very similar situation; and unless earth is "heaped up to form a battery," there is no way of seeing the enemy, and nothing much to prevent a party landing at night and doing what they like with the guns.

Major Alderson's remark on landing shells in the Moncrieff pit was noticed. He was said to have had no difficulty in dropping shells on to a casemate, but very great in dropping—— (Captain SELWYN: Striking.) I understood it was dropping shells into a Moncrieff pit; but that firing, it must be remembered, was with the 13-inch mortar, and these calculations are taken with the 8-inch howitzer. The accuracy of the two is rather different.

With regard to the point Major Moncrieff raised, that an open battery would not be able to resist curved fire, it seems to me if you can put any protection at all against curved fire, there is no difficulty in increasing it as much as may be thought desirable.

The CHAIRMAN: I do not think a more important subject can be brought before us than that discussed to-night, and it is one, the discussion of which we ought to enter into dispassionately, and without professional jealousy or prejudice. There are enormous difficulties in the way of working the guns of the present day. A few years ago they were of moderate size and range, and simple mechanical means, such as the lever, the pulley, and the inclined plane, in the shape of the elevating screw, did everything we wanted, worked by the men themselves; we now require much more elaborate machinery, and a greater power than the mere sinews and muscles of the gunners to work it. We must, therefore, have patience with those who are thinking out this great question; Major Moncrieff is one of them. These matters require grave consideration, and conclusions can only be arrived at by careful practice and experiment. I am sure the meeting will join me in thanking the Lecturer for his very interesting paper.

Evening Meeting.

Monday, 9th June, 1873.

COLONEL THE RIGHT HON. LORD WAVENEY, F.R.S., A.D.C. to the Queen, in the Chair.

NAMES of MEMBERS who joined the Institution between the 20th May and the 9th June, 1873.

LIFE.

Turner, N. O. S., C.B., Col. R.A.
Povah, J. R., Lieut. 1st Royal Scots Regiment.
Johnson, Allen B., Col. Bengal Staff Corps.

ANNUAL.

Goldsmid, Sir Frederic, C.B., K.C.S.I., Major-General.
Bailey, Henry, Lieut.-Col. Grand Trunk Railway Brigade, Canada.
Booth, J. Gore, Lieut. R.E.
Bevington, H. G., Capt. 1st London Artillery Volunteers.
Jopp, Keith, Lieut.-Col. Bombay Staff Corps.
Alexander, Hon. Charles, Lieut. Royal Tyrone Fusiliers.
Aldworth, Robert, Capt. North Cork Rifles.
Marquis, Jas., Col. 17th Bengal Native Infantry.
Toke, John, Major 1st Berkshire Rifle Volunteers.
Bower, J., Lieut.-Col. Hants Mounted Rifle Volunteers.
Turnbull, J. F., Maj. Canadian Hussars.
Gautier, F. E., Capt. Canadian Navy.
Montizambert, C. E., Maj. Canadian Artillery.
McDonough, S., Maj. late 3rd W. I. Regiment.
Harrington, S. C., Esq., Purveyor.

FURTHER OBSERVATIONS ON THE MONCRIEFF SYSTEM OF MOUNTING ORDNANCE.

By Major MONCRIEFF, F.R.S.

I FEEL bound to make the remarks which I have now the honour to address to you, in order to supplement the "Observations on the Moncrieff System," which Lieutenant English read here on the 31st March; the case as left by him not being, in my opinion, quite complete.

An answer to such observations is not easily extemporized. My time is much engaged. I therefore felt reluctance in undertaking the task of making further remarks on this subject *apropos* to such "observations." I know also that what is done reluctantly is seldom done well.

Lieutenant English presented you with a paper very carefully elaborated, and showing much ability, although I am not quite able to agree with all his arguments, or even with the premises on which some of

these arguments are based. My wish is to explain to this meeting that there are views relating to the Moncrieff system which can be held on good grounds, and which are somewhat different from those contained in that Officer's lecture, and my hope is, that I may be able to remove some unfavourable impressions which that lecture was calculated to produce.

Although Lieutenant English's paper was entitled "Observations on the Moncrieff System of Mounting Ordnance," it must have been apparent to those who understood the question, that the Lecturer was thinking more of iron shields and casemates (with which he has been so much identified) and of their advantages, than of the Moncrieff system, which was his text. I felt that it was due to those who would give credit for a certain amount of judicial impartiality to opinions coming from a young Officer of the Works Department, to point out another view of the case, and to give some means of testing the validity of the Lecturer's arguments.

The Lecturer was aware of the following facts:—

1. That the Moncrieff system had only been applied as far as a 9″ 12-ton gun.

2. That it had only been used for open batteries having certain horizontal exposure, and little or no vertical exposure.

3. That it was capable of giving increased lateral range.

4. That in coast defence it would mostly be attacked by ships' artillery. And

.5 That it was cheap.

Accordingly with his paper, he supplied four tables, in which the inferiority of the 9″ 12-ton gun is made to appear. These tables seem to be formed for the purpose of showing that horizontal exposure was nearly as dangerous as vertical exposure. A case of coast defence is selected as the illustration, in which lateral range is not of average importance, and of which there is only one specimen in this country. He assumed that no iron-coated batteries are open in any sense, while at the same time he assumed a horizontal exposure of 27 square feet in Moncrieff pits; and he hinted that a cheap system must be a bad one.

I shall take up the argument in the order above stated, and first direct your attention to the tables that were exhibited at the lecture.

Such tables always have a formidable appearance, at least they have so to me. They speak with that statistical authority which is so much respected in the House of Commons, and by a people like ourselves, who are pre-eminently lovers of facts however ugly may be their garb. I confess to having a vague and indescribable respect for such columns of condensed labour and information. When the Chairman asked the Lecturer where he had obtained his tabular statistics, and received so satisfactory an answer as to their source, nothing more was to be said. Notwithstanding this, however, I was startled to see the averages and the practice from which they were struck. I could scarcely believe my eyes when I saw my old friend the 9″ 12-ton gun had been so much eclipsed by the new rifled howitzer, and by the 10″ and 11″ guns.

In Lieutenant English's tables I find that the 9″ gun has a mean error of 81·1 yards in range and a mean difference of deflection of

4·4 yards at a range of 1,789 yards, while, on the other hand, the 10″ gun at 2,490 yards, that is 721 yards further, has only a mean error of 16 yards in range, and a mean difference of deflection of 1·5 yards.

I had always supposed that the 9″ gun, for which I had provided a successful carriage, ranked in accuracy of shooting with the other pieces in the service, and for some time this disclosure of its inferiority on such good authority, weighed heavily on my spirits. To those of still greater faith than mine the statement must have appeared quite conclusive. A gun that shot so badly must have appeared to them to be indeed of little use. It is true that the gun is powerful enough to sink any light armoured vessel at 2,000 yards or more, and against unarmoured vessels it is as effective as more powerful guns; but if Lieutenant English's tables gave a fair comparison, it could not be expected to do much good, and a Moncrieff carriage might as well not have been designed for it.

As a good many of these guns are in the service, I am glad to inform you that Lieutenant English had overlooked the normal practice of the 9″ gun for his illustration, and had picked out the worst shooting recorded that he could find. The practice from which he selected for his tables related to an experiment for which the 9″ gun was employed, not to determine its shooting, but to observe the effect of firing shot with various forms of head, and with studs of different kinds made of amalgams of copper and tin, and even of soft iron. It was, moreover, noted at this practice that all the shots were noisy and unsteady in leaving the gun. I should also add that both the cases in the tables in which the 9″ gun is given, were taken from this practice. The shooting of the 9″ gun is not, therefore, to be correctly judged by the tables on which the Lecturer's case so largely rests. And I trust, therefore, that you will not allow your minds to be unduly influenced by the character of the figures these tables bring out.*

One would have supposed that an ordinary instance which would have given an average specimen of the shooting of the 9″ gun with nearly the same degree of accuracy as the 10″ gun would have been better suited for this purpose than a case where it was five times as bad in range and nearly three times in deflection. If this result does not prove that the 9″ gun should be put out of the service, Moncrieff carriage included, it shows at least that mistakes in judgment are sometimes made by being too anxious to make out a case. This accident of selection is doubly unfortunate, as, by Mr. English's system of calculating the chances against striking brought out in his tables, it is demonstrated that the 9″ gun has only got a chance in one case of 103 to 1, and in another of 261 to 1 against striking a vertical target, while its rivals in the table, viz., the 10″ gun and the 11″ gun, have chances against striking the same target the 10″ of 6·3 to 1, and 10·7 to 1, and the 11″ of 24·9 to 1; in other words the 10″ and 11″ guns are made 13 times better than the 9″ gun in their shooting. Let us look also for a moment at the results brought out by these tables in regard to the efficacy of fire delivered from ships.

* See Appendix, p. 609 (inserted at Major Moncrieff's request since the reading of his paper.—Ed.).

It was evidently desired by the Lecturer to reduce very much the apparent advantage of having only horizontal exposure, and to make light of the danger of having open ports exposed to horizontal fire, for no other reason, I suppose, than because Moncrieff batteries happen to have horizontal exposure, and, on the other hand, casemates and shields have vertical exposure and open ports. If this was the Lecturer's motive, the desired result is as completely obtained as the condemnation of the 9″ gun, but by another process. It is in this case effected in the tables by some omissions in the calculations of the chances. Simple expedients are generally the most successful. It is quite well known, and requires no tables to prove it, that a miscalculation of range which would only cause an error of inches against a vertical target, might give an error of yards in a horizontal one; and that the difficulty of ascertaining the exact range from a floating and moving battery, is considerable. This chance, however, is not allowed to affect the figures in the tables. Such an omission might have been more indulgently overlooked, had the comparison been confined to shields and casemates alone, which are visible and indeed clearly defined, and their range therefore not so difficult to determine; but when it is extended to a comparison with a species of battery, the principal characteristic of which is, that it gives little or no indication of its exact position, the omission is more difficult to account for, except on the hypothesis that the Lecturer was so desirous to make good his case and to reach his conclusions, that his faith removed on that evening the mountain that stood in his way.

There is another slight omission which one would scarcely have expected to find in a formal statement of the chances of hitting the port of a shield or casemate by direct fire, and considering that the exposure of an opening of 10 or 11 feet radius is shown at 27 feet square for the horizontal target, the vertical target might have had the chance of ricochet thrown in for the sake of appearance. Although this chance has been omitted in the tables, I can assure the meeting it is a chance well worth considering, especially with a shield emplacement, and I shall afterwards refer to it. I put my own interpretation on the character of these tables, and accept them as a high compliment to the new system, which evidently requires to be attacked by very curved fire indeed.

Some good practice with the 8″ howitzer is given in the tables at 40° elevation and 5 lbs. of powder at 2,671 yards range. It is quite certain that sailors are too knowing to attack casemates with so small a charge of powder. I therefore congratulate Lieutenant English on his favourite works being likely to escape from the precision of this admirable weapon. When these howitzers are worked on board ship it would be interesting to determine how much error would be caused at this high angle of 40° by rolling and miscalculation of range added to observed error, and how many times a few guns in Moncrieff emplacements would be likely to hit the ships before the ships could put a shell into the emplacements, firing at 40° elevation; but I would rather that Lieutenant English would not calculate those chances on his own method.

The same free treatment of the subject discovered in the tables, appears to prevail in the arguments.

I suffer a good deal of inconvenience, and my system gets very roughly handled sometimes by a method of attack which I have not yet learned how to meet. I have serious intentions of practising the "kriegsspiel" with the view of getting a hint as to the proper tactics for me to pursue in such cases.

To enlist the kind sympathies of my hearers, I must explain, that methods of applying Moncrieff batteries that I cannot defend, which I never contemplated, and which it would be impossible for me to accept as proper expositions of the new system, are, as occasion offers, imagined, and then under the name of the Moncrieff-system, attacked and demolished.

It is most difficult to know what course to take in these circumstances, so much explanation is necessary. A very common form is to suppose a Moncrieff battery in a position requiring flank defence, which has not been provided; it is then described as having no flank defence, and compared with another battery which has it; the superiority of the latter is thereby established.

A great part of Mr. English's paper is occupied by a detailed description of the attack and defence of a position similar to the Thames at Coalhouse Fort. I have no wish whatever to criticise the views advanced in this part of the paper. The case selected but slightly affects the majority of cases, and the nominal subject of the paper; it is only when it does so that I care to revert to it.

Referring to the arguments relating to foundations in the case selected for illustration, which is the Valley of the Thames with its low and marshy shores, may I be allowed to remark, that when lateral range is unnecessary, and it is at the same time required to put the greatest number of guns on the smallest possible front,—which is very rarely the case,—this can be done by the new system on a smaller front, and consequently on less extensive foundations, than with shields and casemates. Double the number of guns can actually be mounted on the same length of front by the new system. As a rule, however, this would not be done; and it might I think be safely stated by me that the foundations for a 10-gun battery would generally be nearly twice as extensive as those for a 5-gun battery and five times as extensive as those for a 2-gun battery. What, therefore, can the Lecturer mean by remarking as an argument for not using my system, that "the cost of "foundations is a necessary evil, not adding in the slightest degree to "the offensive power of a battery, should be kept down as much as "possible." It is true that it might occasionally be more expensive to break new ground; but efficiency is surely, in a case of this kind, quite as important as any other consideration.

In answer to the statement, that "it is quite impracticable to get over "this difficulty by planting guns in the mud without any foundations at "all," I would venture the remark, that some of the batteries in the London clay on the Medway and the Thames, have been constructed under very great engineering difficulties and at great expense, owing to the impossibility of providing reliable foundations for the weighty super-

structures which the old system requires; and further, that I will stake my reputation as an engineer on being able to establish my batteries in this mud, and form good barracks in the immediate neighbourhood, at a much smaller cost than the others could be constructed for, giving to each battery complete and formidable flank defence by the natural barriers in such ground, viz., wet ditches, &c. High gorges requiring foundations are surely better away if not absolutely required in these positions, in which, for humane reasons, that will be understood by those who have had the ague, the men had better not be permanently stationed except during the threat of war.

The Lecturer states that "the one advantage of extreme lateral "range is to provide against the rather improbable case of one, or of a "small number of vessels attacking a number of heavy batteries." This argument, or assertion, is familiar to me. I would ask, Is it a sound argument; is it a true assertion? and if true in the case selected by Lieutenant English, would it remain true in other cases?

I shall take Lieutenant English's case, as it is weak for me and advantageous for his view.

A narrow channel with flat shores has to be defended. I should suppose that the natural way of doing so, at least of doing so by my system, would be, first to select a favourable point for laying down marine and submarine obstacles, and then to plant the batteries so as to converge on these obstacles, and at the same time to bear down the channel.

If the batteries are composed of guns with small lateral range, such as those behind iron shields, to perform both operations, that is, to bear on the water near the obstacles, and also on the channel for a few miles below them, they must either be massed above these obstacles, or else divided into two classes, viz., those which bear on the obstacles, and those which bear on the channel.

These alternatives have nothing to do with the number of guns and the number of attacking vessels.

If the guns are massed in such batteries as Lieutenant English prefers, they are more easily bombarded, long range or incorrect fire is more likely to tell on them, and they might be more encumbered with their own smoke.

If they are not massed, only one portion of them can bear on the channel below the obstacles, and there is therefore a loss of power, or else an increased number of guns required.

If the front of attack is more extended, and the range of the guns still limited, the enemy would select that part of the sea during the attack for the positions of their ships on which the fewest guns bore; the remaining guns would thereby be *hors de combat*. Limited range of guns is therefore in this case also a waste of power on the part of the defence. I do not see how the Lecturer can get out of this dilemma without selecting some still more abnormal case than he has chosen, and even that would require some ingenuity.

This is so important a part of the whole question that I cannot allow it to be dismissed by such an assertion. Is it the case that "the one "advantage of extreme lateral range" is "to provide against the rather

"improbable case of one or a small number of vessels attacking a "number of heavy batteries?"

Lieutenant English, talking of the ships, remarks—"They would then "concentrate all their fire by signal with battering charges upon one "of the works furthest down the channel at ranges varying from 1,000 "to 2,500 yards." In such a case, might I ask, would or would it not be an advantage to be able to concentrate the fire of all the land guns on the ships, and might I also ask would it be a disadvantage to have batteries on which the battering charges he refers to, would be of no more use than small charges?

Would it be no advantage to have the guns so arranged that the silencing of a few of the batteries would not reduce the exposure of the ships in any one part of the position more than in another part?

Lieutenant English complains that arguments have been founded "on an ideal case of a duel between a single gun in a shore battery and "a single gun on board ship." This cannot, however, be brought against me, as I have never advocated single guns except in positions where single guns are most advantageous. His own hypothesis is, I would submit, equally incomplete, and much more improbable, viz., that if a position was to be attacked, the enemy would invariably station itself to be battered by each face of such shore batteries at once. If the enemy was aware that the lateral range of the guns was limited, so that the guns bearing on one part of the position could not, from being in casemates, bear on some other part, he would, it may be safely stated, prefer some part of the position in which all the casemates could not command him.

Assertions on such a subject, when they come from an Officer of a Department that receives much credit for correctness, have generally more weight than arguments, and they should, therefore, I submit, be carefully considered before they are uttered. I cannot help thinking that had the Lecturer considered his sweeping assertion that the provision he selected was the "one advantage of extreme lateral range," he would have hesitated before stating it in so public a manner.

One of the most important problems that presents itself to the Military Engineer has thus been dismissed by a single sentence.

I would earnestly beg your attention to the following reasons why the increased lateral range imposed by my system, should be very carefully considered, and not dismissed in this manner, as of little value and only available in one case.

The problem of deciding on the proper number of guns to defend a position, is a very important one. Any system which enables the same number of guns to efficiently perform more work is, I would submit, a great gain.

The new system is not only capable of reducing the number of guns, but also of giving the same offensive and defensive power with fewer men.

A large reduction in the first outlay for works and guns is thereby made possible, and, what is of even more importance, a reduction of the garrison can thus be safely effected both in times of war and of peace. The economy effected by obtaining equal offensive and defensive power

with a reduction of men is, I would submit, of the greatest importance.

The Special Committee on Moncrieff carriages, after careful investigation, have reported that "one gun mounted on a Moncrieff carriage "may do equal work with *two or more* guns mounted behind shields." They have also reported that it is superior both in economy and efficiency to the existing system. Additional weight will, I am sure, be given to these conclusions when I mention that the above Committee was composed of the following Officers:—*President:* Major-General F. Eardley Wilmot. *Members:* Col. T. Z. Gallwey, R.E., Col. G. Shaw, C.B., R.A., Lt.-Col. H. Wray, R.E., Lt.-Col. H. Heyman, R.A., Lt.-Col. F. Close, R.A., Major H. G. Alderson, R.A.

In March, 1867, before the new system was tried, and had proved itself to be so thoroughly successful, Lieut.-General Sir J. L. Simmons, K.C.B., to whom the country is largely indebted for obtaining the first consideration of the system, stated that—"When opposed to shipping, there "is very little danger to be apprehended from vertical fire. In such "situations, I have no hesitation in saying that some plan such as this "of yours, if it succeed, will be an immense improvement on anything "we now have, and will be invaluable."

Colonel Jervois also bore testimony to its advantages in a lecture he gave in this theatre; and the late Sir John Burgoyne, and some of the most eminent of our Engineers, have done the same.

His Excellency the Baron von Scholl, whose name will have weight in this Institution, in a letter which he kindly wrote to me regarding the north-east coast of Great Britain, remarks—

"The determining how many guns are necessary to make a position "of the coast, and to repulse a hostile fleet is one of the most difficult "tasks of the Engineer. I have observed that this question in all "published papers, treating of the art of fortification is, as far as I "know, very much neglected, although it is very important, because if "we take too many guns, we offend against economy, and if we take too "few, all money spent is lost, and the Commander-in-Chief of the Army "often relying strongly on his defensive works, may find all his calcu-"lations rudely upset if the enemy succeeds. Therefore, many years "ago, I made long studies on that subject, for many supposed cases "(low or high coast, open sea with deep water, or only channels, direct "or flank fire, &c.), and always I found out that Engineers, before they "decide which is the number of guns to get with them the necessary "security without falling into extravagance, ought to make a careful "examination, not only of the locality (land and sea), but even of the "hostile position and of the number of guns which the enemy is able "to bring into action. If we intend to make resistance, we must know "how to get it; and in this question we always have to examine "what are the enemy's forces. Nevertheless, I would yet say at this "moment that if your carriages are chosen for the lower batteries, fewer "guns are required than in the case of using common carriages. My "own conviction is, that in a low position, where great lateral range is "required, the security of guns upon your carriages is *three* times "greater than with guns upon common carriages. But with respect

"to the fact that everything new finds for a long time a great many "adversaries, I would rather reckon the increase of security at *two* "instead of three times. Considering now that the effect is highly "dependent on the security, I would always say that, for instance, two "guns upon your carriages are equal to four guns upon common "carriages. This is a very considerable advantage, not only in saving "money, but what deserves much more attention, in economy of men, "who always are the dearest article, and especially when they require "such a careful instruction as those who have to work heavy guns."

Compare Lieutenant English's opinion in the following statement with the above authorities. According to him, "The one advantage "of extreme lateral range is to provide against the rather improbable "case of one or a small number of vessels attacking a number of heavy "batteries." And having assumed his dictum thus expressed to be as a matter of course correct, he proceeds to say, "But it is scarcely "worth while to discuss this case, for judging from any successful "sea-attack hitherto carried out, the number of vessels in a fleet "designed to attack shore batteries will always be considerable."

In plain English, this amounts to an assertion, that there is only one case where lateral range is of any advantage, and that such a case will never occur, the inference being, that a system giving increased lateral range, is of no use.

To admit this sweeping condemnation would be to assume that the fire of heavy guns in battery can only be advantageous when delivered to their direct front, a limitation which I deny belongs to the accepted principles of fortification, and which if allowed to have a substantial existence in the mind of a military engineer, would render him a very expensive, if not inefficient, designer of national works of defence.

The next point claiming attention is that of the comparative merits of open or casemated batteries for coast defence.

This expression is used here in a restricted sense. It is intended by the Lecturer, and at present by me, to apply to coast defence by heavy artillery against floating batteries on board ship, and the issue is narrowed to a comparison between open Moncrieff batteries on the one hand and casemated or shield batteries on the other.

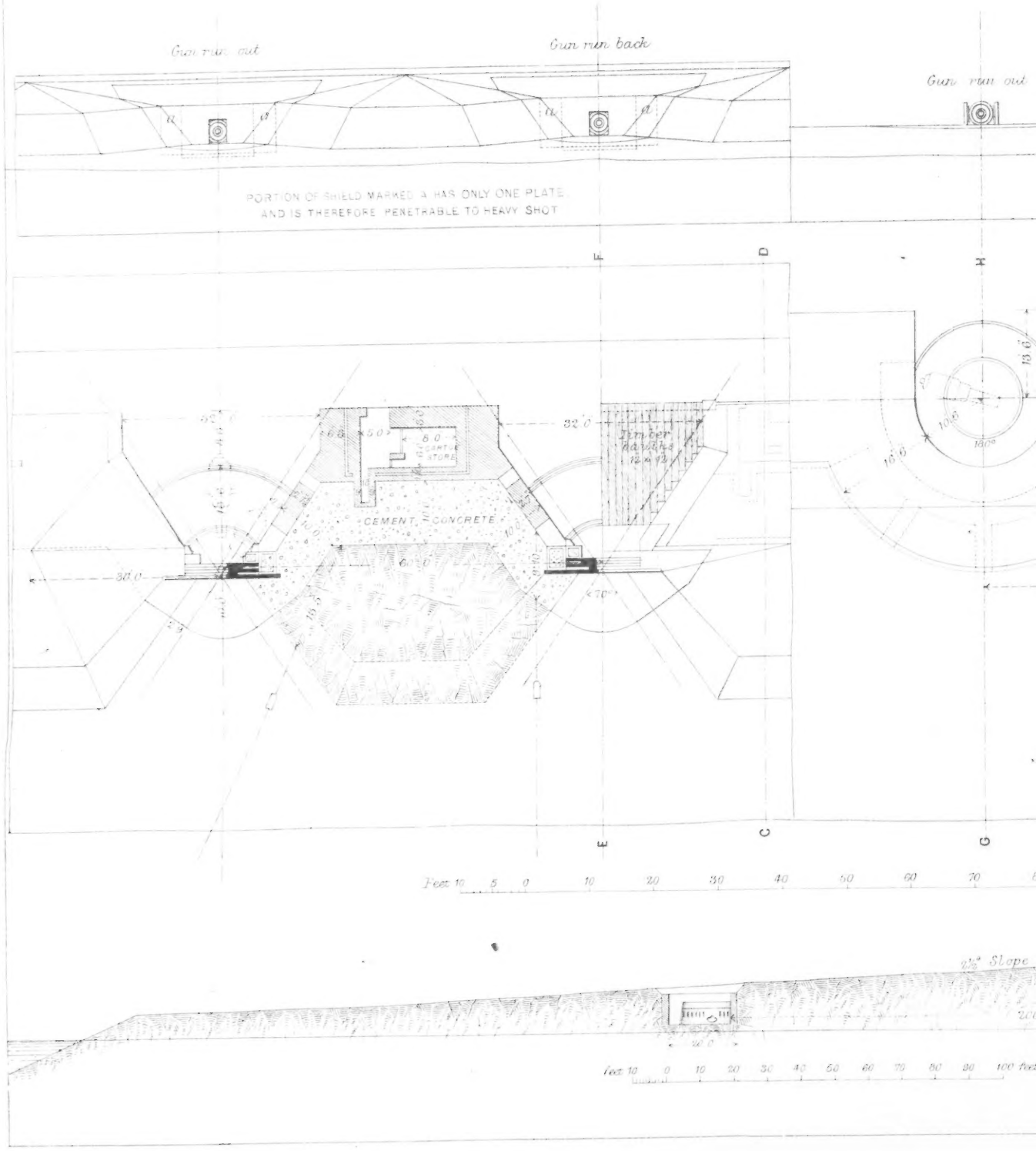
Lieutenant English remarks, "We can, however, by the help of "the reports of practice carried out for range and accuracy, form a "good estimate of what any piece of ordnance can do under the con- "ditions most favourable to it, and for purposes of comparison of the "defensive powers of the two systems as measured by the offensive "powers of the most dangerous fire that can be brought against each, "I think we can arrive at sufficiently accurate conclusions."

An example of the conclusions which Lieutenant English has arrived at is to be obtained from the figures in his tables.

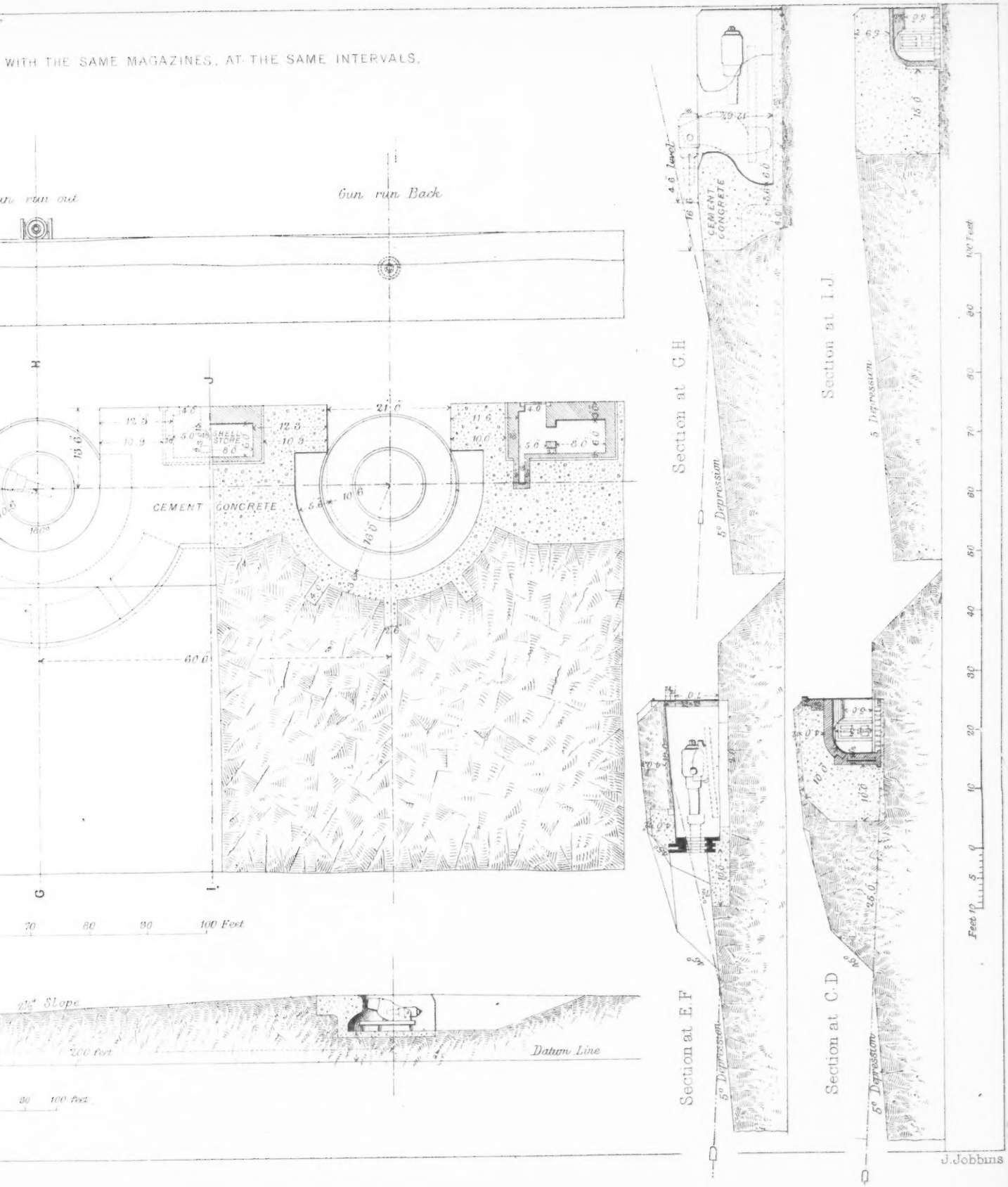
"It may be assumed," he proceeds to say, "that the vulnerable "parts of a casemated work protected by iron shields consists of the "ports."

"As the port may be taken to be a rectangle of 2′—7″ × 4′—0″, the "greatest vertical target presented by it and the margin round it, may "be considered as a rectangle of 3′·7″ × 5′—0″, the breadth diminishing

A COMPARATIVE VIEW OF GUNS MOUNTED IN MONCRIEFF AND IN SHIELD EMPLACEMENTS, WITH THE S
AND WITH THE SAME COMMAND.



WITH THE SAME MAGAZINES, AT THE SAME INTERVALS.



J. Jobbins

" with the horizontal angle of impact." " In Table I annexed" (this is the one I have before referred to) " will be found the chances against " striking such a rectangular vertical target from a steady platform with " various natures of guns, at various known ranges, as calculated from " the series of rounds fired for range and accuracy at Shoeburyness." An ordinary shield battery presents an opening in the exterior slope of more than 200 square feet of vertical area to be fired at. A shot or shell striking at least one half of this area, is liable to be deflected into the port. I should therefore suppose that this liability has as much need to be considered as the chance of a direct entrance. A casemated battery is not in this respect so much exposed; it has, however, the chance of ricochet off the glacis to be considered, and the very serious consequences from shell, if it does enter the port.

Naval Officers, who I would suppose are the best judges of how naval artillery can be applied to greatest advantage, have stated that when land works are to be attacked, they prefer to reserve vertical fire for large objects, such as towns or batteries containing barracks and many guns, and that when they bring direct fire into play, they like to come to sufficiently close quarters to produce the required effect quickly, and above all, they like to see what they intend to attack. If this is a correct statement, I can only ask whether batteries consisting of casemates and open batteries with well-defined exterior slopes with swelling embrasures are the batteries, which are to their liking, or whether they would prefer to attack detached batteries with no pretention to an elevation above the line of glacis.

It appears to me to be only common sense that they would prefer to attack something on which they could observe the damage they were inflicting. The difficulties of determining the exact range at each moment from a moving ship is quite difficult enough, even with the advantage of clearly seeing the position of each gun on shore to make them dislike having to attack batteries which can only be distinguished in the act of firing by the smoke coming from the guns.

Lieut. English remarks in reference to Moncrieff batteries, " It will, " I think, be impracticable to hide the whereabouts of a heavy gun in " action; it is possible, no doubt, completely to screen its exact position " until firing commences, but it will be within everyone's observation " that the puff of smoke produced by the discharge of a heavy gun is " one of the most prominent objects in any landscape; also, at any rate " in this country, with the publicity afforded by the newspaper press to " every detail of the defences, it would probably be found in the event " of war, that the position and nature of every gun was carefully laid " down on the large scale charts of the estuaries and harbours with " quite sufficient accuracy to ensure the range and direction being " known within 50 yards from any position a vessel could take up."

Lieutenant English discredits the advantage of concealment belonging to the new system for two reasons, viz., that the newspaper press will give the position of the guns to within 50 yards, and because puffs of smoke are prominent objects in the landscape.

A miscalculation of range of 50 yards in firing at a casemate or shield is not serious because it would not cause a large error on a vertical

target; and if the error was short of the range, ricochet might give as good a hit as if the range had been rightly judged.

In firing at a properly constructed Moncrieff battery, however, an error of range, either sends the shot clear over the battery, or, if short, causes ricochet, which in this case amounts to the same thing; that is to say, that ricochet from the glacis of a Moncrieff battery sends the shot harmless over it.

With regard to the puffs of smoke, I should like very much to have an experienced sailor's opinion as to his ability to judge the exact range by taking angles on puffs of smoke during action on a number of guns firing at him, and perhaps with a breeze blowing, and whether he would not rather prefer to judge his range in action by seeing the effect of the shot on the exterior slopes of the shield, or casemate batteries, the hits on which can be easily observed, and the range corrected accordingly.

The newspapers may be able to tell the positions of the guns to within 50 yards; but if that is all they can do, the sailors, I suspect, will prefer other sources of information, and, instead of directing their fire by reading the newspapers, they are more likely to lay them by an observation on the ports of the casemates or shields they intend to attack. When such marks are removed by the application of the new system, properly applied, neither the puffs of smoke nor the newspapers will, I should think, afford them an equally acceptable substitute.

It would be a mistake to underrate the value of casemates, where casemates are absolutely required, and I should be very sorry to disparage the one advantage which casemates possess, viz., overhead cover. But at the same time, I am equally averse to arguments that almost indicate a disposition to create positions for the use of casemates; instead of using casemates only where that expensive form of battery is the best alternative.

I imagine that no one can deny that direct fire delivered from land batteries is more correct than curved fire. It will, I think, be also allowed that direct fire from floating batteries has, if anything, a still greater advantage over curved fire delivered from ships.

The comparative value of open batteries as against casemates is therefore greater on sea faces than on land faces.

This argument is valid when the comparison is only between open shield batteries and casemates. How much more so is it applicable when the comparison is between casemates and a new class of battery that increases materially the difficulty of range-finding and correct aiming, and thereby renders curved fire less effective, and, as a necessary consequence, reduces the value of overhead cover which is the only advantage over open batteries that casemates possess.

Is the overhead cover of a casemate employed for coast defence really so important that it justifies that form of battery being generally adopted for sea faces in preference to a new class of open battery, which has greater offensive power by means of increased lateral range, and from being less encumbered by its own smoke; is much more difficult to attack by curved fire than any other open battery, the range of which is easier judged; has a parapet which cannot be breached by

direct fire; in which the men are completely protected from direct fire by having no port; and which, notwithstanding all these advantages, is also much cheaper? I venture to think that if Lieutenant English had carefully weighed all these considerations, he would perhaps have modified the opinion expressed in the following sentence:—

"A comparison of the two methods of defence will, I think, show "that the best chance of success in the example of a fortified position "which I have selected is offered by the use of guns properly protected "by casemates."

The Lecturer stated that the "probable requirements of the future," when "vessels plated with thicker armour are constructed," and when a heavier shore armament is required, is an argument against my system. I should have thought that it would be a much more serious argument against iron-plated works, because increased thickness of ships' armour is likely to be accompanied with increased power of artillery; and whereas the former, that is the armour, is limited by the flotation-power of the vessels, the latter, viz., the guns, have no such limit to their increase of power; it would, I submit, be much more serious to find the shields too weak than the guns not powerful enough, and for the above reason it would not only be more serious, but would, in fact, be more likely to be the case.

If new and more powerful guns are in future required for some coast batteries, they can be mounted in the old Moncrieff emplacements, and the less powerful guns removed to new emplacements made for their reception in any position for which they are better adapted. These new emplacements would cost much less than would new iron batteries adapted for the dwarf traversing carriages which pertain to iron works. Besides which the old iron batteries, for the reasons above stated, would probably require to be strengthened for the new armament.

Lieutenant English makes a statement in his paper to which I wish publicly to take objection, as it is calculated to mislead, now misleads, a great many Officers, has prevented a comparative trial between my system and shields, and specially because it is constantly used as an argument for justifying delay.

The statement is as follows:—"A 9" gun pit cannot fairly be com- "pared with a shield which has been found by direct experiment to "be completely proof against the 25-ton gun."

The words of this statement, as far as the iron is concerned, are true. It may, perhaps, surprise some of my hearers to know, however, that the comparison based on it is utterly incorrect and unfair.

The word shield may be used in two senses as meaning the mere iron, or it may be used for the whole shield emplacement; or, in other words, for that part of a shield-battery occupied by one gun.

The shield itself is no more than a block of iron with a hole in it, called the port. This shield would fall to the ground unless supported. It is by itself of no use. It must be fitted into a parapet formed of earth and concrete, or other materials, before it is employed. There must also be a platform provided for the gun and magazines, &c., for ammunition. When supplied with these accessories, it is then, and not till then, in a state to be compared with a gun-pit, which provides all such requirements.

It will perhaps surprise you, however, to be informed that a shield-battery in that sense "has not been found by direct experiment "to be completely proof against the 25-ton gun," as stated by the Lecturer, and that, so far from this being the case, a shield-parapet has not even been fired at or tried in any way. The vulnerable area exposed to direct fire in such a shield-battery is more than a hundred times greater than that exposed by a Moncrieff pit, exclusive of the cover with which it is proposed to furnish these batteries, and which is an additional element of weakness against direct fire. It is allowed that direct fire is more correct than curved fire, and yet the proposal to try the shield-battery by firing at it, is not entertained.

The shield-battery is accepted without a trial as perfect, with all its doubtful points, simply because the iron part of it has shown certain powers of endurance, while its rival, the pit, with fewer doubtful points, is alone to be tried, and the proposed trial has been used as a reason for delay.

Lieutenant English, while referring to the doubtful points which are to be solved by a proposed trial of a Moncrieff pit, is therefore contented to allow it to be supposed that the doubtful points in a shield-battery have been found to be completely proof against the 25-ton gun, the fact being that the iron, which is the strongest part of a shield emplacement, was alone subjected to the direct experiment he refers to. It will thus be seen that a wrong impression is created by coupling a fact with an irrelevant comparison. The only trial which would bear on the case was one made with the 13-inch shunt gun, which gave a maximum penetration into stiff clay of 50 feet. The thickness of a shield parapet between the magazine and the exterior slope is about 32 feet, 10 of which are of concrete; and there are weaker points in the parapet than the one in front of the magazine.

I would here wish you to consider another statement of the Lecturer—that "all shields which are not casemated are prepared for "the reception of over-head cover." These shields are, therefore, intended to be made into casemates before they are used. If they are to be made into casemates, surely it is worth while to try how they answer as casemates when exposed to direct, and I may also add, curved fire as well as the batteries which are now their rivals, and which are not so easily seen and aimed at by an enemy. I am extremely anxious to have both Shield and Moncrieff batteries subjected to experiment, as they are rivals; I have no doubt whatever as to what would be the result.

With regard to the element of expense. The Committee on Moncrieff carriages have reported that—"As compared with the cost of a case-"mated battery with shield, as estimated for a 9" gun of 12 tons, the "balance in favour of the Moncrieff system would amount to about "£1,800 per gun, while as compared with an open battery with shield, "with and without splinter proof cover, the saving would be respec-"tively £450 and £667 per gun." The same Report states that "one "gun mounted on a Moncrieff carriage may do equal work with two "or more guns mounted behind shields." Mark what the effect of this would be in relation to expense. Every gun thus saved would be,

in addition to the above saving, an economy of the most important kind.

In the case of a casemate, according to the estimates in the report, it would save—

The gun	£769
Carriage	379
Battery	3,849
	£4,997

In the case of a shield battery—

Gun	£769
Carriage	379
Battery with splinter proof	2,642
	£3,790

To this saving, ranging from £3,790 to £5,000, must also be added the saving effected by reduction of men, which the Baron von Scholl estimates much higher than the first price of the works. I may here remark that the above figures are not mine, but they are taken from the official report based on the estimates of the Works Department.

If therefore the proper saving on each gun be added to the cost of those guns and works which can be dispensed with, and the cost of maintenance and garrisons required to work them, the total saving on each Moncrieff gun will amount to a considerable sum.

Lieutenant English alludes to my system as a cheap and imperfect one. It is to say the least extraordinary that he can do so in the face of the last Report on Moncrieff Carriages, which must be known to him to have pronounced in favour of "guns mounted on Moncrieff "carriages as compared with guns mounted in the ordinary way;" on the following points, which, it will be observed, include all that constitutes the efficiency of a heavy gun, viz.:—

1. Facility of loading.
2. Facility of laying.
3. Rapidity of fire.
4. Exposure to the enemy.
5. Protection afforded to the men.
6. Protection to the shell-rooms and magazines as compared with that afforded behind iron shields.

I venture to suggest that few military inventions of modern times have offered so fertile a source of efficiency and economy.

The objections raised by Lieutenant English have required so much space to answer them, that I am unable to do what would have perhaps made my remarks more interesting, viz., to have introduced you to new ground, and to new appliances for a further application of my system.

For this reason I must at present confine myself to a simple intimation that a new invention of mine for the Navy, employing hydro-pneumatic agency, which was announced here in 1870, and has recently been applied by Sir William Armstrong and Co. for the Dutch Government, has proved so satisfactory, that I have been able

to recommend its adoption in another form to land service for the heaviest artillery. This invention was first submitted to the English Admiralty in 1869. The success of my own experiments with this new system enabled me to give designs for its application to siege carriages for the English Government, at the request of the Committee on High Angle Fire; this application was alluded to by me, and partly described in this theatre on the 8th May, 1873.* The carriage referred to has since then been tried with success.

The success of these siege carriages will open up a new and interesting field of application unconnected with heavy artillery, and they may be found pregnant with important results. The other application of the same system to very heavy artillery, will in my opinion, also prove to be most important, and I hope on some future occasion again to bring it specially under your notice. It may interest you to know that when employed for guns of great weight, the cost which counterweight carriages for very heavy artillery imported with them, is removed. The system is entirely different from that which I was employed by the English Government to apply, and no assistance whatever has been afforded me by the Government in maturing it. This has led to a great loss of time; and in acknowledging the help I have received from the Dutch Government and Sir W. Armstrong and Co., I would state that but for that help, its application to naval purposes would have been a dead letter up to the present time. Some day it may be discovered that a very heavy expenditure has been incurred in continuing the manufacture of turrets, &c., that might have been saved by a more complete investigation of this new system. I wish to avail myself of this opportunity of publicly thanking Sir Wm. Armstrong and Company for the handsome manner in which they, after becoming acquainted with my principle, offered to guarantee to the Admiralty its successful action in the first application.

Mr. English remarks that "the Moncrieff system is as much in its "infancy now as iron plates were ten years ago." I would ask who is responsible for this? is it they who have consistently disparaged it and thereby kept it back, or he who, under difficulties and discouragements of no ordinary kind, has devoted his time, his means, and professional labours for its proper development in this country?

If the Moncrieff system in its infancy has proved itself to have so many advantages, what is it likely to be when it is as cordially and practically acknowledged as iron works have been? I have been restrained from feelings of delicacy from expressing in public my opinions on the way in which every trifling objection is allowed to cause delay; but when an Officer in Lieutenant English's position comes forward and openly discredits the utility of the work which I have been assiduously carrying out for the Government, I feel bound, in duty to myself and to the Departments I serve, to mention as much as I have done in this paper; and I have refrained from bringing forward more facts than are necessary to meet the case.

Besides extending and perfecting the counterweight system for the

* Lecture to Officers of the Auxiliary Forces.

Government, I have, as above stated, also developed a new one with my own resources which has already succeeded in each case in which it has been applied, and which promises to be as successful in all respects as the other. The new system has the remarkable advantage of being most useful where counterweight is not so applicable, as for instance in ships, in travelling siege carriages and for guns of very great weight.

Everything, therefore, connected with my Government work as well as with my own, is now satisfactory, except the delay. Each counterweight-carriage that I have designed for the Committee on Moncrieff carriages has answered beyond expectation, has required no alterations, except of the slightest kind, and all of them continue to work after great exposure and proloniged trials, as well as at first. The further the system has been applied, (as far as the carriages are concerned,) the better it succeeds. Notwithstanding this, it has not yet been allowed to go beyond a 12-ton gun, and the manufacture of those service carriages which are adopted, proceeds but very slowly. There must be some reason for this; what can it be? It is not want of efficiency, of economy, or of success—it is simply that the opponents of the new system have so much influence that they are able to instil doubt and cause delays. These opponents are the advocates of iron. The doubts which they have succeeded in raising, and the successful stand which they have made against progress, proves what very great influence they possess. That influence has hitherto been exercised without open expression.*

Lieutenant English has done good service in expressing so openly and so ably the opinions that prevent progress; but unless better arguments and stronger facts than his are adduced, I submit to you and to my countrymen, and particularly to those in Parliament, who are responsible for the expenditure of the public funds, that it is an injustice to me, and an injury to the taxpayer, to deprive the country of the full advantages of the new system on such grounds. I say *full advantages* advisedly, as in no case has it yet been applied so as to bring out its full advantages. In the defences of the Severn, of Cork Harbour, of Bermuda, &c., the Moncrieff system is largely employed. The Moncrieff batteries in these works, as they are constructed and placed, may be equal to, or better than, shields or casemates; but such of them as I have seen, are not by any means advantageous examples of the system they represent. This opinion was stated by me in my official reports.

I now appeal to the Officers of the English services who have so often supported me before, dispassionately to weigh the arguments on both sides, and if they see the truth of my views, to assist me in overcoming the passive resistance that opposes me at every point.

I appeal also to the sense of justice of my opponents as to whether it is right to cause delays in extending the application of my system to heavier guns, and at the same time to use as an argument for applying its rival, that mine is in its infancy.

* I should here wish to express my acknowledgments to the Works Department for urging forward the application of the new system at various times when it was all but standing still, and for the general support it has received from that department.—A.M.

I would also ask them if it is right to prevent a proper application of the new system which would illustrate its full advantages, and while doing so, to use arguments for applying casemates derived from the imperfect treatment thus imposed on their rival.

I would further observe that there is a large field of application for my system quite removed from the debatable ground on which the Iron and the Moncrieff systems have each got a foot, and that the controversy between the advocates of each system need not be allowed, as it is now, to delay applications of Moncrieff carriages, where no one disputes their superiority.

In my desire to meet the arguments and statements in the lecture, I trust that I have said nothing harsh or uncalled for to Lieutenant English, who I dare say can have no idea of the anxiety I have endured, and the difficulties I have had to contend with, in carrying out my system during a period embracing a good portion of a lifetime.

In conclusion, I beg to thank that Officer for bringing this subject before the public and lifting it out of the slough of despond, where it has too long been detained. I trust it will now remain before the public, open to the intelligent criticism of professional men, until every doubt has been removed and all fallacious arguments that have hitherto been permitted to carry with them undue weight, shall have been satisfactorily and conclusively refuted.

I cannot finish my remarks on this subject without gratefully acknowledging the support which I have received from the British Government. Their recognition has encouraged me to subordinate my private interests to the service of the State. It has given me confidence that when the time arrives, whatever is worthy in my system, will be fully acknowledged and properly applied. The pecuniary reward which has been bestowed on me is greater than has often been given to men of much more ability than mine for public services; and although I do not look to that form of recognition as my only aim, it has doubtless enabled me to do more justice to the calling I have selected; and I am not unconscious of the implied confidence which such a grant represents. It will be no small satisfaction to me to see the Government reap the full credit and advantage of the important step they took when they adopted my system, which will be the case as soon as it is properly applied.

APPENDIX.

Both the following extracts are from the Reports and Proceedings of the Ordnance Select Committee, which are in the library of the Institution.

The one from vol. iv gives the normal practice of the 9-inch 12-ton gun, and that from vol. v, as will be noticed, is special experimental practice, and is the table from which Lieutenant English quoted.

EXTRACT FROM MINUTE 18,991, 6/6/66. Vol. iv, Part II, page 130.

Rounds Fired from 9-inch Wrought Iron Rifled Muzzle-loading Gun of 12 tons for Range and Accuracy.

Date.	Number of rounds fired.	Charge, weight, and length.	Projectile.	Corrected elevation.	Mean recoil.	Time of flight corresponding to mean range.	Ranges.			Mean difference of range.	Mean observed deflection.	Mean reduced deflection.	Remarks.
							Minimum.	Maximum.	Mean.				
		lbs. 30 ins.	lbs.	° ′									
May 11.	10	9·25	250·4	1 28	4·4	1·95	700	767	731	14·7	1·6	0·3	
„ 11.	10	„	„	3 14	4·3	4·03	1438	1539	1474	24·1	3·8	0·8	
„ 11.	10	„	„	5 9	4·1a	6·36	2239	2305	2283	18·0	5·4	1·1	
„ 11.	10	„	„	7 7	4·0	8·64	2905	3133	3034	51·9	9·9	1·5	

NOTE.—All the practice in the table from which this extract is taken was made for range and accuracy, and the portion quoted above is that on which the range tables for 9-inch rifled muzzle-loading guns were prepared for both land and sea service guns.

a. Mean of 9, 1 not observed.

EXTRACT FROM MINUTE 23,338. 21/10/67. Vol. v, page 320.

Practice with 9-inch Wrought Iron Rifle Muzzle-loading Gun of 12 tons, carried out in execution of several programmes combining the following points of inquiry:—

1/2/67. Part of 40 Palliser shot, 1·25D studs of an alloy of 7 copper, 1 tin
10 „ studs soft wrought iron
40 „ 1·5D, studs of the above alloy
10 „ studs soft wrought iron.

Trial of Various Forms of Head, and different Studs.

Date.	No. of Rounds Fired.	Projectile. Brand.	Projectile. Radius of Head and Studding.	Corrected elevation.	Mean recoil on a dry platform.	Time of flight corresponding to mean range.	Ranges. Minimum.	Ranges. Maximum.	Ranges. Mean.	Mean difference of range.	Mean observed deflection.	Mean reduced deflection.	Compressor at hole.	Remarks.
				° ′	feet.	sec.	yds.	yds.	yds.	yds.	yds.	yds.		
22/8/67	5	A1	1·5 D. Soft wrought iron, rear of rear studs usual distance from base.	1 19	6·4	2·32	884	1035	940	43·8	1·8	1·8	3 & 5	
23/8/67	5	A1	1·0 D.	1 19	6·2	2·21	924	973	942	17·2	0·8	0·9	5	1 unsteady.
3/9/67	10	A5	1·5 D. 7 copper, 1 tin. Rear of rear studs 2¼ ins. from base.	3 10	7·1	4·79	1650	1960	1789	81·1	4·4	4·4	4 & 6	All noisy and unsteady. Compressor did not act for 5 rounds.
2/9/67	10	A5	1·5 D.	5 7	6·1	7·34	2450	2722	2633	79 6	6·2	5·6	4	9 unsteady, 2 jammed at 2 ft. from end of bore. Compressor did not act for 1 round.

NOTE.—The above extract includes the whole practice referred to in Minute 23,338. Lieutenant English's quotations are confined to that of the two last days.

The CHAIRMAN: Having heard Major Moncrieff's lecture, I invite Officers to offer any remarks they may wish to make. Perhaps some gentleman will also give us information on a subject which will not turn on the difference of opinion between iron shields and gun-pits, I mean with respect to the application of this principle to the armaments of ships of war and to guns for siege works.

Lieut.-General Sir LINTORN SIMMONS, K.C.B., R.E.: I have listened with great attention to the lecture which has been given to us by Major Moncrieff, and am sorry I had not the advantage of hearing Lieut. English's lecture; but I think we may come to the conclusion with regard to each, "There is nothing like leather." Major Moncrieff sticks to his pits, Lieutenant English to his shields, and both are making a very good fight for their respective *protégés*. I would observe, however, having had an opportunity of seeing the tables which were exhibited at the last lecture, that they are calculated somewhat to mislead. I may be wrong, the view I have had of them having been only very cursory, but they appear to be fallacious in several respects. First of all, as to the size of the target which is presented by an embrasure. The actual opening is 2 feet 7 inches by 4 feet, and reasoning from a shot fired some time ago at an experimental shield, which struck but did not perforate the shield within 7 inches of the open port-hole, Lieut. English adds 6 inches all round, and considers that a shot striking outside that line would do no injury to the battery. Now, I think this is slightly erroneous. In the first place the diameter of the shot must be added to the opening, which would make it very nearly 5 feet 7 inches in one direction and 6 feet in the other. Then I think what has been pointed out by Major Moncrieff on the board is a perfectly valid objection to these tables. There is a very large area, not only in the shield itself, but in the parapet which is vulnerable; and if open batteries are protected by extemporized overhead cover, which is not supplied by

the construction of regular casements, that area will be increased very considerably, because all the overhead portion will be exposed to direct fire, and if a shell were to go into it, it is very probable that it would be damaged and the efficiency of the battery might be seriously affected. Then as to that overhead cover, I do not know how it is intended to be constructed, but it appears to be partly timber and probably partly earth. Now I would observe that the effect upon it of heavy rifled shells fired at high angles has not been tried, and I should doubt very much whether such cover would resist the fall and explosion of two or three such shells; at any rate, a very large increase must be made to what may be considered the vulnerable part of the battery, by addition for the horizontal space in rear of the shields. It is not fair, in my humble opinion, to consider the port-hole and a small space around it in an open shield battery, as its only vulnerable or weak point. A large amount of effect should be allowed for vertical fire, which I believe would be very nearly equal to that to which the Moncrieff pit is subject. Next, as regards the 9-inch and 10-inch guns; I must confess I have been perfectly astounded at these comparative tables of practice. I have attended a good deal of practice myself and have seen a good many tables of practice, but I was not at all prepared for the general effect stated in these tables. It appears from Table I that the 9-inch gun, at a range of about 1,750 yards, is likely to throw one shot in 103 into one of these embrasures and the 10-inch gun one shot in 6·3. In other words, only at this range the 10-inch gun has sixteen times more accuracy than the 9-inch gun. This is a result I was not at all prepared for. A few lines farther on in the Table I find similarly that the 11-inch gun is ten times more accurate than the 9-inch at a range of about 2,650 yards. That also is a fact I was not at all prepared for; and I should like very much to hear what the constructors in the Arsenal have to say to this, because it is not at all creditable to them, if these facts be as stated, that there should be this great difference in the accuracy of these guns. I think the only conclusion to be drawn from these tables is one which has been known for ages,—that direct fire should be used to attack a work presenting a large vertical exposed surface, and vertical fire to attack a work which presents only a large horizontal surface through which it can be injured. There is, however, this great difficulty in attacking a work which only presents a horizontal target such as the Moncrieff battery, that it cannot be seen where the shots strike, and therefore there is no possibility of correcting the accuracy of the fire. If you fire at a work covered by a long glacis with a gentle slope at a range of 2,500 yards, or even less, you cannot tell from the deck of a ship, even with the best telescope, whether the shot strikes within 100 yards of the crest or not. That at least is my firm belief. The angle subtended at that range by even 100 yards of a gentle slope is so small that you cannot distinguish within that distance how near the shot strikes the object, and therefore there is great difficulty in correcting the practice if the shot fall short. If they go over the work still more, there is no possibility of knowing where they go to, nor therefore in this case also of correcting for range. Another objection that has been taken to the Moncrieff pit is, that an enemy would know from newspaper reports within 50 yards where every gun is placed. Granted this may be so; but there are two conditions necessary for accuracy of fire. It is not only necessary to know where the guns are, but also to know your own position with reference to them; and I should like to hear the opinions of the naval Officers present as to the chance of taking up a position in action and ascertaining the range of the guns within 50 or 150 yards, especially if there is not some well-defined object, such as an embrazure or a flag-staff, upon which to direct their instruments and take their bearings. I suspect also that naval Officers will guard themselves very much against remaining stationary when under the fire of land batteries. They will, I rather think, keep moving, if they possibly can, slowly, so as to bother the defender's artillery; but in so doing they trouble themselves; they are constantly changing the ranges of their own guns, which renders it exceedingly difficult for them to keep up a steady and accurate fire upon small objects, or those which present only a very limited vulnerable area. There are some positions in which iron shields may be used with great advantage, and there are others also in which Moncrieff pits may be used with undoubted advantage, but I think that engineers who are responsible for the construction of great works of defence should try to hold a neutral position, and after weighing the advantages and disadvantages of the various systems, should avail

themselves of the inventive genius of any gentlemen who devote their energies and talents to the service of the country in this way, and apply their inventions in those positions in which they may be used with the greatest benefit. I would observe, however, with regard to shields, that not only do newspapers give information of the positions of the batteries, but they even enter into such details as the amount of training of the guns in them. Now, if that be the case,—and I think it cannot be doubted that is the case, because all our experiments are made public and the whole world know them,—the construction of every shield in the service is perfectly well known as well as the amount of training that every gun mounted behind it, is capable of,—if that be the case, in attacking them an enemy will look as much to the training of the guns as to their position, and will try to place his ships out of the direct fire of the greatest possible number of guns, as was said by Major Moncrieff; and I think in that way, especially where the guns are intended for the defence of open channels, great advantage might possibly be taken of the knowledge of the lateral training of guns. The example that appears to have been taken by Lieutenant English as the basis of his arguments, namely, the defences of the Thames, is particularly favourable for iron shields; but batteries are intended, not only for the defence of narrow channels of that description, but also to protect open roadsteads and many other positions; and I think there can be no doubt that in many such cases the Moncrieff pit may be used with great advantage. I will only observe with reference to the last observations made by Major Moncrieff that I think it is very much to be regretted that we have not more experience of his hydro-pneumatic carriage. From what I have seen of the model, and from what I have heard of some experiments that have been made, it seems to me a most useful and valuable invention, not only for naval purposes, but also for land defences, especially where heavy guns have to be used. I should like very much indeed to hear the results of experiments that have been made, to know to what extent they have gone and what is the heaviest weight of gun hitherto mounted on a carriage of this nature, as I think it is an invention which is likely to be productive of the greatest possible benefit to the country.

Admiral Ryder: When your gun, Major Moncrieff, is fired with the hydro-pneumatic apparatus, is there enough force stored up to bring the gun up to its position again?

Captain Selwyn, R.N.: We have heard of the faint praise which condemns, and I think we have in Lieutenant English's paper a magnificent specimen of faint attack, which is a high compliment on Major Moncrieff's system. It was a paper which I confess did not at the time convey to me any great reasons for distrusting that which I have so long supported, that idea which first came before us in this Institution some years ago now, and has slowly made its way against a great deal of opposition; nor do I think that this evening's paper will give Lieutenant English any reason to think more strongly of his arguments than he did before. But there are some points on which I should like to answer Major Moncrieff's questions, as far as one member of the naval profession can do, and I have no doubt my brother Officers will speak further on the same points. Lieutenant English relies considerably on an idea that attacks by small numbers of ships on heavy batteries are abnormal. I think if we go back over the history of the old wars, when ships were not defended by iron, we shall find that it was a very favourite amusement with captains of frigates, whenever they had not much else to do, to run down the coast and attack any fort they could get near. In some instances they not only pounded them a little, but they landed, took the forts, and dragged the guns down the beach with chains, before the relieving troops could come up to help the battery. I recollect reading a very graphic account of such an attack, I think, under Lord Cochrane, when the guns were made fast by chains to the ship's capstans, and so hove off in spite of the attempts made by the enemy to sever the chains before the guns got to the sea. Such things were done then, and I think our modern sailors would not be reluctant to attempt at least the repetition of such feats. But in making those attacks, there are certain things which no sailor ever does if he knows his work. He never goes under a very highly placed gun, because, even though he may command an ironclad, a gun with great command can bore a hole through the decks, and out at the bottom. Nor is a very heavy battery to be encountered with great effect, if you begin a long way off; and all our successful naval actions, fought with heavy batteries, have been at the very

shortest range within which it was safe to anchor the ships. We are perfectly aware of the truth of what Sir Lintorn Simmons has said, that we cannot anchor ships particularly in a tide way with any very great exactitude; unless we moor, the current will sweep the ship about, and when we are at single anchor, the cable, being the radius of the circle at the extremity of which the ship moves the circumference of the circle in swinging, represents a very large possible error. That is still more the case where in rivers the currents change their course as the tide increases or diminishes in strength. That which I mentioned in the discussion on Mr. English's paper regarding the practice at a target at Gibraltar will serve to show that there are all these uncertainties attendant on the fire of ships, and that we do prefer very naturally, first, the largest target we can get, and, secondly, at least something that we can see. What we should not like, is precisely that beautiful green hill, out of which a gun ascends, delivers its fire, and recoils again totally out of our sight. With regard to lateral fire, there is a point which has not been made enough of in Lieutenant English's paper, and which deserves very great consideration from those who have to defend themselves against ship attacks. It is this, that a ship advancing up a river in passing a battery, and in continuing her course, is exposed to two different natures of fire, to one of which she has comparatively no means of resistance, and by which she is very easily hit; the other, for which she is specially prepared, and which she ought not therefore to fear so much. She advances end on, and if any shot at a long distance strikes anywhere within her own length, the ship may be said to have from 200 to 300 feet of length exposed of the deck, through which if a shot goes, with the curve due to long range, it is extremely likely to disable either her engines or screw. She suffers the same inconvenience after she has passed the battery. Therefore what she does is to advance to the battery as quickly as possible, if there be no torpedoes to hinder her, and then to deliver the full weight of her fire, and take the pounding she receives in turn when she arrives opposite the battery. There her armour stands in good stead, and she clouds herself in smoke, and trusts that the battery may kindly do likewise. Those are things which I think were left out in the consideration of Lieutenant English's paper, when he stated that naval Officers would prefer to moor some 1,200 or 1,500 yards off, and then concentrate their fire on the batteries. It is just what I should not do; I do not know what my brother Officers feel about it. The puffs of smoke which are so prominent an object on the landscape, are also very deceitful objects. I defy any man to tell me whether a puff of smoke is advancing towards him rapidly, or going from him rapidly, or with what rapidity when under fire. I defy any man to estimate by the angles of the sextant what the exact angle of a puff of smoke is with another puff of smoke, or with a tree, or some other such object. I should be very reluctant to base any accurate range-finding on such considerations; my calculations would be much more than subject to personal error. As to mooring within 50 yards range, I have shown it is utterly impracticable. I think we could possibly take up our position, even under sail. I am quite sure those Officers who have studied naval tactics recently with our present means of turning steamships rapidly, would undertake to take up their posts within something short, perhaps, of 150 yards, but they could not be certain that they would keep that, and it would sometimes be very inconvenient that they should keep it. Sir Lintorn Simmons has said we should prefer to move about a little, and to change the range as much as we could. With regard to the size of the port shown in these shields, I want to draw attention to the fact that gun muzzles have shown of late years rather a tendency to increase in size, and it is not quite certain if our ports are calculated as 2 feet 7 inches wide, that it will permit these new guns to be fired through them at all. It is quite certain, on the other hand, that all our experiments hitherto on granite and concrete have shown us that they are unreliable materials on which to base an idea of invulnerability. The shield proper is dependent for its retaining its vertical position, or its being perfectly out of winding, as we should say, upon the solidity of the concrete, and shots destroying the concrete at each side may very speedily block the whole gun fire, and this is a case which can never occur with the gun-pit. I can see a port, I can fire at it, and if I hit it I shall see more or less damage. But I cannot see the gun-pit, and when I do hit it I shall not know what I have done; there are no means of telling what effect my fire has had. Those are differences which sailors would consider as very great objections in their attack on a

Moncrieff fortification, and proportionately valuable to the defenders. The hydro-pneumatic carriage has, I must say, engaged my attention and my admiration more than anything else that I have seen come from Major Moncrieff's hands. He has there forced into his use for a particular purpose two separate mechanical appliances which have not hitherto been successfully combined on a large scale. It is quite clear that had the hydraulic force alone been relied upon, the shock given would have rendered the whole system impossible; it was clear, on the other hand, that with air alone, an efficient tight air piston is yet to be discovered; but by the combination of a water piston with an air-pressure, he has mastered a problem which I must say has, on the mechanical mind, an equal effect to that produced on the artistic mind by the master who produces a great work of art. He has given us a gun-carriage, too, and this is the valuable portion of it to naval men, by the use of which we can at last hope to have armour not dependent on the coming gun for its solidity of resistance. The coming gun nobody knows how big it will be. Not long since Mr. Bessemer told us he would not stop short at 600 pounds; he would not mind converting the pounds into tons at once. Under those circumstances we want some armour very badly indeed, which shall have a constant power of resistance, and be unaffected by any weight of metal. That armour is only to be found in the water; there is no other armour known that will resist such shot. But that armour is only available when the gun, the gun's crew, and everything else can be carried below the water, and can be brought up for use. We could not do that before, but Captain Moncrieff's invention has enabled us to do it. Whether it be in this little boat, or in the largest ironclad we now possess, I mean to say for the future no attention need be paid—and this was a question gentlemen present will recollect Mr. Barnaby put before us very strongly—no attention need be paid to the protection of guns or crew, the only thing that requires protection now is the life of the ship. I will only ask to be allowed to say one other word, and that is with reference to the advance which has been made by the Dutch. I recognise with great pleasure the fact that our old and worthy enemies on the water have been able to appreciate this invention. I am only sorry it should ever be said that the English constructors were led into the future by a Dutch gunboat.

Major KNOLLYS: Sir Lintorn Simmons put the case very impartially and fairly, showing that there are some positions in which the iron shields would be desirable, and others in which the Moncrieff pits would have the advantage. Nobody has given Engineer Officers stronger or better lessons in adapting means and appliances to circumstances than Sir Lintorn Simmons, particularly as regards fire. I refer to the works at Eupatoria. But I venture to think that though there may be some occasions on which the iron shield may be superior to the Moncrieff pit, as a rule the Moncrieff pit will be superior. I venture to go so far as to say that in my opinion Major Moncrieff's system has initiated a revolution in the art of fortification. I have a synopsis put into my hands directing me to impress upon those who attend my classes—I am a Garrison Instructor—the advantage of command. I am obliged to carry out my orders; but I always say in my opinion it is no advantage, but, on the contrary, a positive disadvantage, and I base that opinion chiefly on the experience of the Prussians round Paris. There they in principle adopted Major Moncrieff's system of protecting their guns, for the over bank system after all is only Major Moncrieff's system. They took advantage of the brow of a hill, and presented no sign of a battery whatever, and until the gun was fired the French were unable to tell that there was a gun there in position. With regard to the shields, there must be some limit to their strength, but in Major Moncrieff's system there is no limit whatever to the amount of protection given from direct fire by his pits. There is another very considerable advantage which has not been mentioned, which is connected with the repelling of descents on our coasts. For all the more important points we shall no doubt be prepared; we shall either have Moncrieff pits or shields, forts, and so on. But the enemy may discover some place where he can land his forces which has been overlooked by us. Now by making skilful use of the Moncrieff system, in a very few hours the most ordinarily-trained soldiers of the Line would be able to construct cover for a large number of guns.

Lieutenant ENGLISH, R.E.: Major Moncrieff said a paper like mine or like his could

not be answered very well *viva voce*. I quite agree with that opinion, and must beg to be excused from offering any remarks on the general question, leaving my paper to stand with his, for consideration. But there are one or two points that I should like to remark upon. He alluded to the practice of the 9-inch gun as compared with the 10-inch, in the tables in my paper. The comparison was between the chances of striking a vertical and a horizontal target with the same gun in each case, and therefore it seems to me that the chances were fair; whether the shooting of the gun was good or bad it was the same for the vertical target as for the horizontal. There were some examples of extremely good, and some of certainly indifferent shooting, and, as a matter of fact, I did not pick the rounds, but took them haphazard.* I do not think, whatever they were, they materially affected the question. Then, with regard to the deflection of shot into ports by earth or concrete embrasures, Major Moncrieff said every shot that struck 200 feet of the flaring cheeks would be deflected into the port—— (Major MONCRIEFF: Half that area.) There are surely many other directions in which it would be deflected. Half, I think, is a very large proportion, and it must be remembered that the number of shields with flaring cheeks bears to the total number of shields in use, the proportion of one to twenty. I think Major Moncrieff said the thickness of armour must be limited by the floating power of ships, but that surely would not apply to batteries, and that the armour of land batteries would have to be added to from time to time. That is no doubt the case, but I do not think there is any material obstacle, except expense, to doing it. Sir Lintorn Simmons said, in the case which I had taken of a vertical target, where I had added six inches margin all round the port, that the diameter of the shot should have been added to that. In the experiment at Shoeburyness, from which the figures were taken, the point of the shot struck seven inches from the margin of the port only. With regard to ships being stationary or moving under fire, of course, as a landsman, one cannot be expected to give a sound opinion, but I adduced the case of the attack on Fort Fisher, in the American war, where I believe the whole fleet was anchored, one may say, for days together; and even if ships were not anchored, surely the change of position is as unfavourable to the accuracy of striking a vertical target as to that of striking a horizontal one.

Captain HOSEASON: There is one remark I should like to make, viz., that the argument has gone off a great deal on the difference between 9-inch, 10-inch, and 11-inch guns, but I understand Major Moncrieff is the inventor of carriages and has nothing to do with the guns; therefore if there is any defect in the gun it rests with those who furnish the gun, not he who furnishes the carriage.

Lieutenant SELBY, R.N.: I should like to ask whether the disparity of shooting with the 9- and 10-inch guns took place under similar circumstances of weather and on the same day?

Major MONCRIEFF: In answer to Sir Lintorn Simmons' question as to the weight of guns which have been mounted upon the hydro-pneumatic carriages, I beg to state that first of all I had manufactured for my own use and for experiments, a carriage for a 16-pounder gun, from which I got very satisfactory results. The next carriage made on that system was for a $12\frac{1}{2}$-ton gun. That carriage was constructed for the Dutch Government, and in this diagram there is a representation of the form in which it is applied. There is a hood not fully shown in the diagram which covers the gun and the Officers who direct it from musketry or shell fire. The gun fires over the bow on a non-traversing carriage. The working of the gun is satisfactory. It is true that the recoil does not carry the gun exactly to the loading position. This, however, is owing to the contraction of the hydraulic passages and valves of which I may say I foresaw the result; and I believe in the next construction the full recoil will take place. There will be

* Since Major Moncrieff's paper was read, I have ascertained that the 18 rounds from the 9-inch gun referred to by him as fired with "shot with various forms of "head, and with studs of different kinds made of amalgams of copper and tin, and "even soft iron," were all fired with shot of the present service form of head, and with studs composed of the service gun-metal. (See "Extracts Ordnance Select Committee," vol. v, page 320, in the library of the Institution.)—T. E.

sufficient power stored up by the recoil in the form of compressed air to raise the gun again to the firing position. Indeed the action of raising the gun is one of the most easy that can be conceived. The gun can be raised quickly when the operator chooses, or it can be raised with such delicacy that I believe one could crack a walnut by the muzzle of the gun without breaking it completely. The third case in which this new system has been applied is for a 64-pounder siege carriage; this has been made for the English Government. The 64-pounder is probably the heaviest class of gun required for siege purposes, for this reason, that it approaches the limit of weight which two wheels will support on ordinary roads. Last week I conducted an experiment in the north of England with this carriage in which I obtained satisfactory results. From my experience of this new system in each application (and which has not as yet been carried further only from my want of power and means of applying it more rapidly), I think I may predict for it a very prosperous future. With regard to Lieutenant English's remark as to the deflection of the projectiles from the cheeks of the embrasures of shields, in my paper I stated that the vertical area of exterior slope exposed to be hit, amounted to 200 square feet, and that shot striking one-half of that area would be liable to be deflected into the port; this estimate, I think, is modest and safe; the angle of deflection of rifled shot is not always quite equal to the angle of incidence; this need not, however, decrease the liability of shot going into the port. Indeed I myself believe that the chances of a shot entering the port by ricochet are considerably greater than the chances of entrance by direct fire; but that is one of the questions which cannot be satisfactorily decided by theory, and therefore I regret very much that the authorities have so often postponed the trial of a Shield and a Moncrieff parapet. When such large sums of money are expended in the manufacture of shields and shield emplacements, I do not think it would be extravagance to discover what are the qualities of the parapets into which they are formed. I hope that experiments will be made not only with these shield batteries, but also thoroughly to test the Moncrieff system. I think I may allow the very favourable comments that have been made on my paper to answer all the other questions that have been asked.

The CHAIRMAN: It has been most happily stated by a Naval Officer during the present sitting, that Major Moncrieff has combined two forces, not wholly antagonistic, but each of which would compensate the varying elasticity of the other in the hydro-pneumatic carriage, and we have observed with great pleasure the uniform result of what I may call the smooth working of the gun-carriage. But I may remark here, especially, how great a power is to be derived from a scientific and thoughtful application of the forces of nature when the philosopher (and I place Major Moncrieff by right of his design in that class), when the philosopher converts the enemy into the friend and servant. Every Officer, particularly those who have had much practice in firing from granite works, even with guns on traversing platforms, must remember the constant vexation arising from, in the first place, the racers being displaced by the shock of the gun transmitted through the carriages, the injury to the carriages themselves, and from the continued difficulty of maintaining all on an equal level, in result of the vibration which tears the gun-carriage to pieces, and opens the seams even of a granite embrasure. But Major Moncrieff has, by converting this destructive agency into a friend and servant, placed the gun out of fire, and, in fact, has rendered a service to the manipulation of artillery which was previously unknown. It has given me particular satisfaction to preside on this occasion. I was one of the first, I believe, who had the advantage of becoming acquainted with the Moncrieff carriage. I remember well, though I was not present on the occasion, the first experiment made in public in Edinburgh, under General Hamilton. The gun was a 32-pounder, with an old-fashioned carriage; not the finished machinery that we here so much admire. In that case, so perfect was the absorption of vibration that the gun was scarcely moved a few inches. From that moment, it was clear that the hostile powers of nature had been mastered, and had been converted, under the guidance of science, as I have remarked, into a friend and servant. In conclusion, I would refer to the use that has been made of this system by the Dutch Government. There is no Government on the Continent of Europe that is more determined to increase and enlarge its artillery service, and its means of artillery defence, than the Dutch Government. An Officer, well known to the

artillery service, told me, the year before last, that he was at the great foundries in the north of Europe, and there he found a Dutch Officer superintending the casting of not less than 1,100 guns for the Dutch Government. Whether they were to be mounted on Moncrieff gun-carriages, I do not know; I trust that they will be, and that our countryman's fame will be displayed in the smallest fort that watches the entrance to the Texel or the Zuyder Zee. I should very much like to see some experiments of the combined action of the Royal Engineer Service and the Royal Artillery carried out on one of the most important points of the English coast, the point from which our future operations, if we are ever called upon to carry war into Northern Europe, must necessarily be based, and that is the harbour of Harwich. Sir Lintorn Simmons will be well acquainted with the nature of the defences of that harbour. A slight addition would make it impregnable to the heaviest ironclads. The sea entrance is defended by a battery having four iron shields, covering heavy guns, two of which look seaward, one towards the fairway coming from the sea, and one into the harbour. There the iron shields would, I believe, be most useful, because the inshore course is such that an ironclad attacking must either come in and engage landward before it could proceed into the harbour, or it must lie outside the shoals and engage from a distant position. But there is a point still to be occupied for defence, which would, with impunity to the defending force, cover the entrance into the harbour. It is the Beacon Hill, and has a command of about 56 feet at low water. It is on that point I would suggest that one of the Moncrieff gun-carriages could be placed with perfect concealment. It is a place on which a battery was erected during the French war; it is a battery from which I have fired many hundred rounds, and from this experience I suggest this addition to the shore armament. For an extemporised defence of our coast, we must have also some field batteries answering to Sir Howard Douglas's mortar train. I was, therefore, particularly anxious that Major Moncrieff should give his attention to the transport along roads, without reference to railways, of siege or position carriages, and I understand from the siege or travelling carriage now exhibited, that it is available for this purpose, which appears to be of the very greatest importance.

Major MONCRIEFF: Sir, the question of applying my system for guns which are able to move about to different positions, was discussed by me in this theatre about a month ago, and the lecture that I then gave is now in print.* I should wish to express the satisfaction that I feel in having your Lordship as President at this meeting, as one of the very first men in England who recognised the importance of the system which I have endeavoured to introduce.

The CHAIRMAN: I believe I am only expressing your opinion in saying that we owe our best thanks to Major Moncrieff for the explanations he has given us. I think I should not fully express your feelings if I did not also add our satisfaction that British Officers may differ in opinion thoroughly, and yet meet to discuss the same with the most perfect advantage to both sides.

---

* Lecture to Officers of the Auxiliary Forces delivered 8th May, 1873. Since published by Stanford, 6 and 7 Charing Cross, in a pamphlet entitled "Suggestions "for Supplementing our Coast Defences on the Moncrieff system."

LECTURE.

Saturday, May 31, 1873.

Captain H.R.H. THE PRINCE ARTHUR, K.G., in the Chair.

THE TACTICS OF THE THREE ARMS AS MODIFIED TO MEET THE REQUIREMENTS OF THE PRESENT DAY.

By Captain H. BRACKENBURY, R.A., Professor of Military History, Royal Military Academy.

(*Delivered at the Special Request of the Council.*)

YOUR ROYAL HIGHNESS AND GENTLEMEN: The glance which I have been able to cast round this room has increased the sense of responsibility with which I undertook to deliver this lecture, and I will ask you to allow me to say, before entering into my subject, that the position in which I find myself to-day is not of my own seeking. It was not until I had more than once very strongly urged upon the Council of this Institution, that they should place in the hands of an officer of greater experience and higher rank than myself this most important lecture, that I consented at their repeated instance to deliver it, feeling that there was a point where my objections must cease, and that at last it became a duty to comply with the request of so distinguished a body of officers as that composing the Council of this Institution.

We have now arrived at a period when the necessity for some change in tactics, as they have been practised by the British Army, is generally, I will not say universally, acknowledged. This desire for change has been brought about by improvements in arms; therefore, before we can arrive at correct conclusions as to what the change should be, we must examine those improvements. But first let us go for a moment to the very root of the whole art of tactics.

What is our object in battle? It is to break down the enemy's moral force, and to sustain the moral force of our own troops. As Laymann so well puts it, it is better to kill fifty men in an enemy's battalion, if that makes the rest run away, than to kill a hundred men if the rest stand firm.*

Now the means of demoralizing the enemy are practically two, fire and shock, either of which is helped and assisted by surprise. Shock has not increased in power since the middle ages; fire has enormously

* "About Tactics." By Captain Laymann, Instructor in Tactics at the Royal War School, Cassel. Translated by Capt. E. M. Jones; p. 9.

TO

ry,

ave
pon-
ask
ition
not
il of
r of
tant
ling
last
body

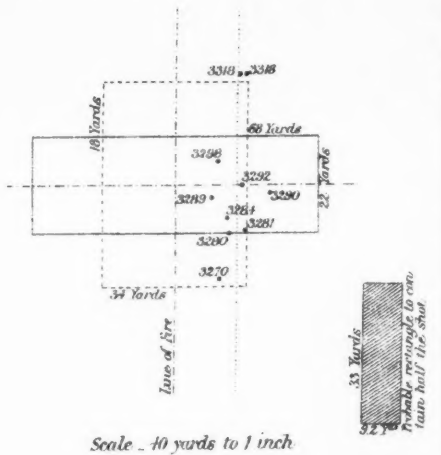
ange
ally,
has
can
nust
the

my's
As
my's
men

fire
hock
ously
Royal

Nº 1

DIAGRAM showing the positions on the horizontal plane of the hits of 10 rounds fired from the 9 Pr Rifled M.L. Gun, Charge 1 lb 12 oz. Elevation 10°. Mean range 3292 yards. The rectangle shewn thus ..... represents a Battalion in quarter distance column, its centre corresponding to the mean range. The rectangle marked with firm lines represents a Battalion in double company quarter column. The intersection of the lines marked ..... and ..... gives the point of mean impact.

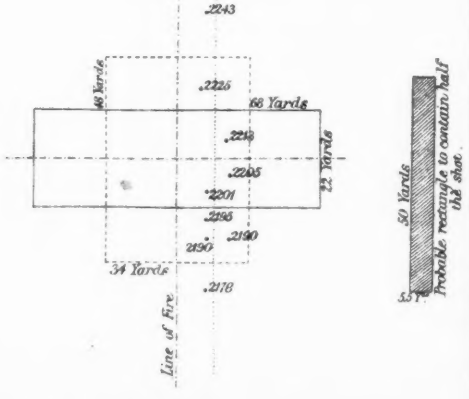


Scale – 40 yards to 1 inch.

3318 (2) would have cleared the firm line rectangle, but struck the rectangle shown thus .....

Nº 2

DIAGRAM showing the position on the horizontal plane of the hits of 10 rounds fired from the 9 Pr Rifled M.L. Gun, Charge 1 lb 12 oz. Elevation 5°. Mean range 2209 yards. The rectangle shewn thus ..... represents a Battalion in quarter distance column, its centre corresponding to the mean range. The rectangle marked with firm lines represents a Battalion in double company quarter column. The intersection of the lines marked ..... and ..... gives the point of mean impact.



Scale – 40 yards to 1 inch.

Nº 4

EFFECT OF ARTILLERY FIRE ON LINES OF TR

9 Prs AND 16 Prs M.L.R. GUNS.

Line of targets 45 feet long by 9 feet high.

Range	Nature of Amm^n	Total hits 9 Pr	Total hits 16 Pr
1500	Common shell	46	36
do	Shrapnel do	92	345
2000	Common do	26	30
do	Shrapnel do	75	276
2500	Common do	24	36
do	Shrapnel do	100	131
3000	Common do	13	32
do	Shrapnel do	66	105

Front of a Company of 50 files, 34 yards long by 5 feet 6 high.
Front of a double Company 68 yards do do do.

Nº 5

RETURN showing the hits *per cent.*, or destructive e fire, with the Snider rifle, at the regulation targets, tional effect on bodies of troops in different form distances:—

Mark aimed at.		200 yds.
Battalion	In line	96·
	Quarter column	99·61
	Double company quarter column	99·53
Half-battalion	Quarter company	99·41
	Double company quarter column	99·23
Double company	In line	95·89
	Company quarter column	98·77
Company	In line	95·77
	Half company column	99·1
	Column of sections	98·82
Regulation targets, 200 yards, 6′ × 4′; 500 yards, 6′ × 6′; 800 yards, 6′ × 8′		90·

Remarks.—At 200 yards the shooting is standing, a from the knee, and at 800 yards in any position.

The battalion is supposed to consist of 800 men, divi panies of 50 files.

The calculations are based on the mean *individual* infantry at the School of Musketry during the past y include the ricochet hits, which in actual war are a fair hits. Of course if the firing took place in mas vidually, it would not be so good. However, the probably balance the deduction which would have to account. The shooting of the infantry at the Schoo much superior to the average performances of the army

The results in this table have been obtained thus:—

Taking 200 yards as an example: the misses are 1 6 feet high by 4 feet wide. It is assumed that the pe tical and lateral errors are inversely proportional to th or 4 and 6 p. c. For any larger mark, such as a compa sections, the proportional per centage of vertical an is calculated on the same principle, and the sum ded gives the per cent. of effective hits. The depth of the sidered equivalent to the height of a target of the s It must be remembered that comparative results are estimating the absolute destructive effect of infantry deductions from the above would have to be made o distances being unknown, smoke, excitement, &c., &c.

SCHOOL OF MUSKETRY,
Hythe, 30th May, 1873.

NES OF TROOPS.

UNS.
high.

tal hds 161[st]	
36	
345	
30	
276	
36	
131	
32	
105	

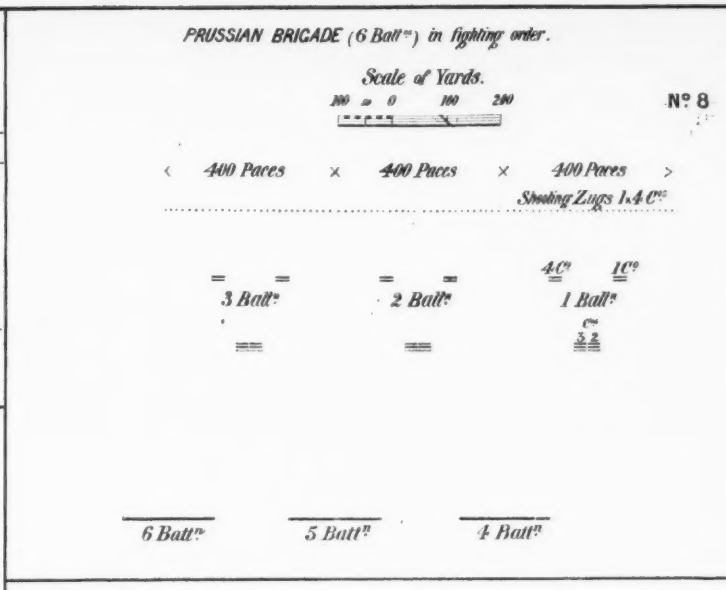
et 6 high.
do do.

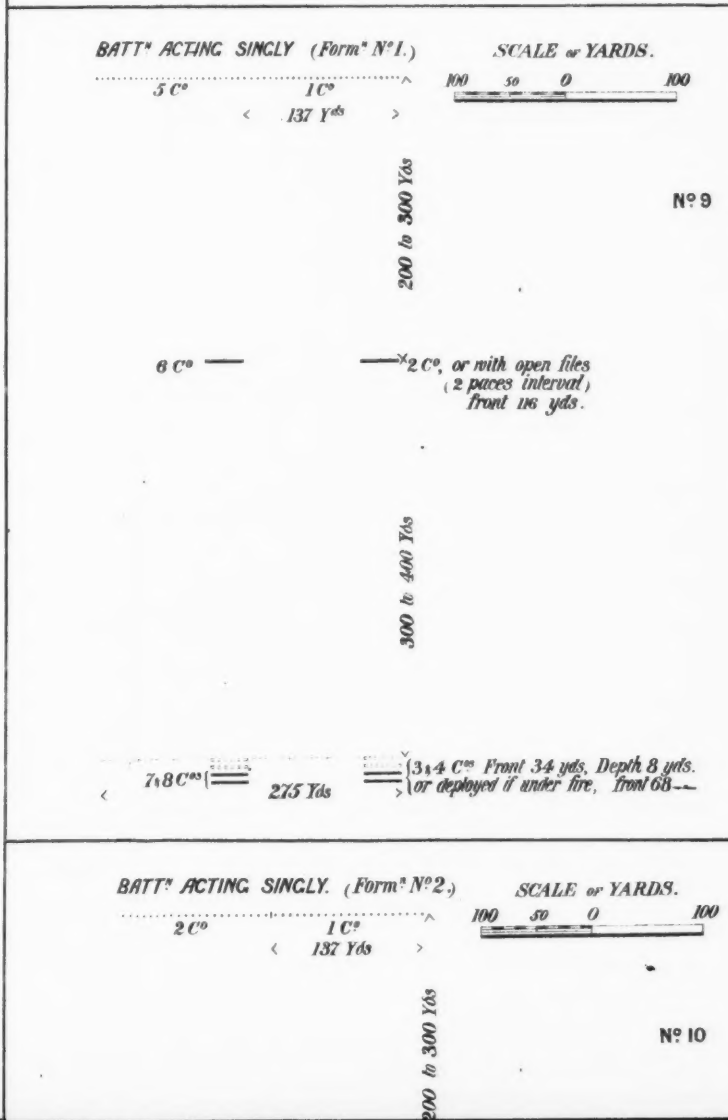
destructive effect of infantry
ation targets, and the propor-
ifferent formations at various

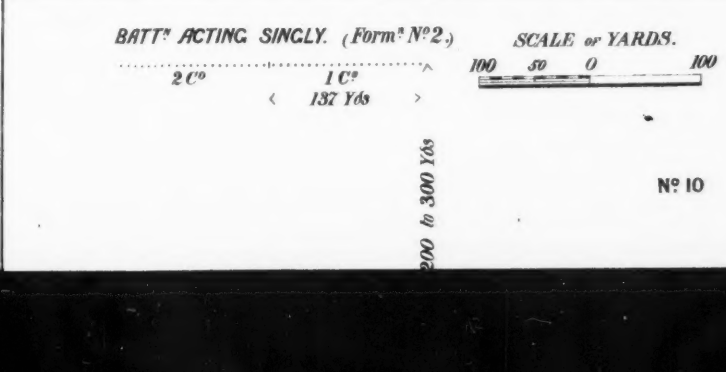
	Ranges.		
	200 yds.	500 yds.	800 yds.
.....	96·	80·5	59·
.....	99·61	98·05	95·86
mn..	99·53	97·73	95·07
.....	99·41	97·09	93·85
mn..	99·23	96·18	91·86
.....	95·89	79·93	57·79
.....	98·77	93·99	87·32
.....	95·77	79·36	56·57
.....	99·1	95·56	90·59
.....	98·82	94·17	87·57
ds, ..	90·	61·	28·

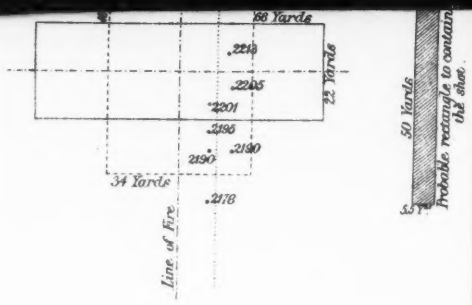
is standing, at 500 yards it is
sition.
500 men, divided into 8 com-

on *individual* shooting of the
ng the past year, and do not
al war are as destructive as
place in mass instead of indi-
owever, the ricochets would
uld have to be made on this
at the School of Musketry is
s of the army generally.
ained thus:—
misses are 10 p. c. at a target
that the percentage of ver-
ortional to these dimensions,
ch as a company in column of
f vertical and lateral misses
the sum deducted from 100
depth of the column is con-
rget of the same dimensions.
e results are here given. In
t of infantry fire, very large
be made on account of the
ent, &c., &c.




BATTN ACTING SINGLY (Formn Nº 1.)
SCALE of YARDS.
100 50 0 100
5 Co
1 Co
137 Yds
200 to 300 Yds
Nº 9
6 Co
2 Co, or with open files (2 paces interval) front 116 yds.
300 to 400 Yds
7 & 8 Cos
275 Yds
3 & 4 Cos Front 34 yds, Depth 8 yds. or deployed if under fire, front 68





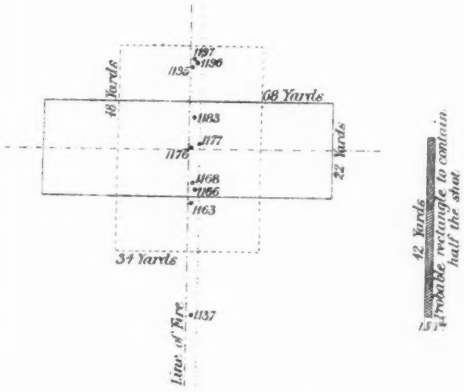
Scale – 40 yards to 1 inch

2251 would have cleared both columns. 2243 would have cleared the firm line rectangle, but struck the rear of the broken line rectangle. 2225 would have struck the firm line rectangle. All the shots that struck in front would have done execution.

N° 3

ABSTRACT FROM REPORT OF SPECIAL COMMITTEE OF FIELD ARTILLERY FOR INDIA, 1869. P. 22.

***DIAGRAM** showing the positions on the horizontal plane of the hits of 10 rounds fired from the 9 Pr. Rifled M.L. Gun, Charge 1lb 12oz. Elevation 2°. Mean range 1176 yards. The rectangle shown thus ... represents a Battalion in quarter distance column, its centre corresponding to the mean range. The rectangle marked with firm lines represents a Battalion in double company quarter column. The intersection of the lines marked ... and ..... gives the point of mean impact.*



Scale – 40 yards to 1 inch

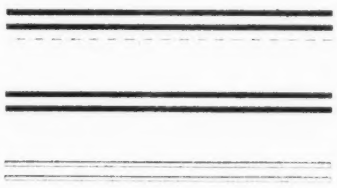
All the shots would have struck the columns either before or after graze.

6 feet high by 4 feet wide. It is assumed that the p
tical and lateral errors are inversely proportional to
or 4 and 6 p. c. For any larger mark, such as a comp
sections, the proportional per centage of vertical a
is calculated on the same principle, and the sum de
gives the per cent. of effective hits. The depth of th
sidered equivalent to the height of a target of the
It must be remembered that comparative results are
estimating the absolute destructive effect of infantry
deductions from the above would have to be made
distances being unknown, smoke, excitement, &c., &c.

SCHOOL OF MUSKETRY,
Hythe, 30th May, 1873.

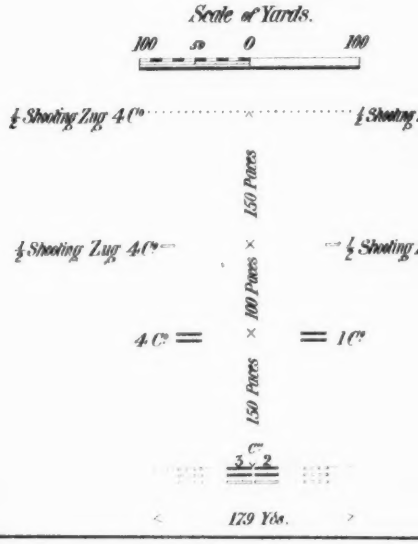
N° 6

FORMATION OF A COMPANY COLUMN



N° 7

***PRUSSIAN BATTALION** (800 Men) in fighting or*
(Vortreffen and Hauptreffen.)



e misses are 19 p. c. as a target
ed that the percentage of ver-
portional to these dimensions,
uch as a company in column of
of vertical and lateral misses
the sum deducted from 100
e depth of the column is con-
arget of the same dimensions.
ve results are here given. In
ct of infantry fire, very large
o be made on account of the
nent, &c., &c.

ANY COLUMN.

in fighting order.
ottreffen.)

8.

100

½ Shooting Zug 1C°

½ Shooting Zug 1C°

= 1C°

7 & 8 C°s = 275 Yds = 3 & 4 C°s Front 34 yds. Depth 8 yds. or deployed if under fire, front 68 yds.

BATT.N ACTING SINGLY. (Form.s N°2.)

SCALE OF YARDS. 100 50 0 100

2 C° 1 C° 137 Yds

200 to 300 Yds

N° 10

4 C° 3 C°, or with open files (2 paces interval) front 116 yds.

300 to 400 Yds

275 Yds.

5 6 7 & 8 C°s Front 34 yds. Depth 22 yds. or in double C° Cols or deployed if under fire.

BRIGADE ACTING SINGLY. (Format.s 1 & 2.)

SCALE OF YARDS. 100 0 100 200

6 C°s 5 2 C°s 1

438 Yds

N° 11

2.ND BATT.N

C°s 8 7 C°s 4 3

300 to 400 Yds.

3.D BATT.N 1.ST BATT.N

875 Yds.

or in double C° Of Cols: at deploying interval.

The numbers given to the formations in Diagrams 9 to 15, correspond with the paragraphs and sections of

PRUSSIAN BRIGADE (6 Battⁿˢ) in fighting order.

Scale of Yards.

100 ... 0 ... 100 ... 200

Nº 8

< 400 Paces × 400 Paces × 400 Paces >

Shooting Zugs 1x4 Cᵒˢ

4Cº 1Cº

3 Battⁿˢ 2 Battⁿˢ 1 Battⁿ

Cᵒˢ 3.2

6 Battⁿˢ 5 Battⁿ 4 Battⁿ

ⁿ ACTING SINGLY (Formⁿ Nº 1.)

SCALE or YARDS.

100 50 0 100

5 Cº 1 Cº

< 137 Yᵈˢ >

200 to 300 Yds

Nº 9

6 Cº — — 2 Cº, or with open files (2 paces interval) front 116 yds.

300 to 400 Yds

7 to 8 Cᵒˢ 275 Yds 3 x 4 Cᵒˢ Front 34 yds, Depth 8 yds. or deployed if under fire, front 68 —

TTⁿ ACTING SINGLY. (Formⁿ Nº 2.)

SCALE or YARDS.

100 50 0 100

2 Cº 1 Cº

< 137 Yds >

200 to 300 Yds

Nº 10

Nº 12

BRIGADE ACTING SINGLY. (Formatⁿ 3.)

100

5 Cᵒˢ 1 5 Cᵒˢ 1

200 to 300 Yds

6 Cº 2 Cº 6 Cº 2 Cº

2ⁿᵈ BATTⁿ 1ˢᵗ BATTⁿ

300 to 400 Yds.

7,8 Cᵒˢ 3,4 Cᵒˢ 7,8 Cᵒˢ 3,4 Cᵒˢ

300 to 400 Yds.

3ʳᵈ BATTⁿ

< 575 Yds. >

Nº 13

DIVISION FORMATION 1/

One battalion covering front of division

—

1ˢᵗ BRIGADE. in formatⁿ 1

400 to 600 Paces.

2ⁿᵈ Brigade

12

at" 3.)

SCALE of YARDS.
100 ⇒ 0 100 200

200 to 300 Yds

2 Cos

300 to 400 Yds.

3,4 Cos

300 to 400 Yds.

DIVISION SECOND FORMATION 1/1
Front 575 Yards, covered by two battalions.

Scale of Yards.
100 ⇒ 0 100 200

Nº 15

1st BRIGADE.
in formation 3.

400 to 600 Yards.

2nd BRIGADE.

3

MATION 1/1
ront of division 875 Yds.

E. in formats 1 & 2

de

114 Yds. 228 yds.

Nº 16

2000 yards

7 & 8 Cᵒˢ — 275 Yds — 3 & 4 Cᵒˢ Front 34 yds. Depth 8 yds. or deployed if under fire, front 68 yds

Tᵉ ACTING SINGLY. (Formˢ Nº 2.)

SCALE OF YARDS. 100 50 0 100

2 Cᵒ — 1 Cᵒ — 137 Yds

200 to 300 Yds

Nº 10

4 Cᵒ — 3 Cᵒ, or with open files (2 paces interval) front 116 yds.

300 to 400 Yds

275 Yds

5 & 7 R Cᵒˢ Depth 22 yds Or deployed if under fire.

1ˢᵗ BRIGADE. in formatⁿ I

400 to 600 Paces.

2ⁿᵈ Brigade.

Nº 14

DIVISION FORMATION $\frac{1}{2}$

Front 1175 Yards, covered by four battalions

ADE ACTING SINGLY. (Formᵗˢ 1 & 2.)

SCALE OF YARDS. 100 to 0 100 200

Cᵒˢ 5 — 2 Cᵒˢ 1 — 438 Yds

Nº 11

2ⁿᵈ BATTⁿ

Cᵒˢ 4 3

2ⁿᵈ BRIGADE. in formation 3.

1ˢᵗ BRIGA in formation

ATTⁿ — 1ˢᵗ BATTⁿ — 875 Yds. — or in double Cᵒ Qʳ Cols: at deploying interval.

ns in Diagrams 9 to 15, correspond with the paragraphs and sections of the general order of 22ⁿᵈ March, 1873.

OE. in format: 1,2

de.

TION 1/2

four battalions.

Scale of Yards.

100 50 0 100 200

1st BRIGADE
in formation 3.

2000 yards.

720 yards

No 17

DIAGRAM SHOWING SAFETY POINT FOR ARTILLERY FIRE OVER HEADS OF INFANTRY.

Range 1000 Yds.

		Highest point of Trajectory 30 Ft.
30 Ft.	Straight	
" 1500 "	133 yds.	" 72 "
" 2000 "	103 yds.	" 139 "
" 2500 "	73 yds.	" 335 "

1873.

increased in power, and hence we find that the chief aim of modern offensive tactics is to obtain the greatest possible development of accurate fire, as being the surest means of breaking down the enemy. On the other hand, as fire increases in power, so does it become more difficult to sustain the moral force of our own troops. This is effected by the following means: first of all, discipline in its truest sense, not mere repression, but that discipline which, as Carlyle puts it, "is a kind of miracle; it works by faith:" faith of the men in their officers, not only in their courage, but in their skill; a discipline which does not give way at the moment that the soldier is removed from the immediate supervision of his officer. Secondly, training suited to war, so that the soldier is not paralyzed by finding himself in strange situations, but acts correctly from habit and from the knowledge of the best course under all conditions. Thirdly, giving confidence by success at the outset of war, for it is intensely difficult to re-establish moral force when once it has been broken by defeats early in a campaign. Next, protecting troops in action by shelter; using ground, natural cover, in the very best way, and if none such is available, artificial shelter under certain conditions; and also by moving troops, so as to take them out of the worst and most destructive shot spheres. Lastly, adopting those tactical formations in which troops suffer least from fire.

Now discipline, training, and success at the outset of a campaign are gained by our previous conduct and our organization in peace. Training during peace will alone enable an officer to protect his troops from fire when he leads them in battle. Tactical formations must also be decided upon in peace; all change at the outbreak of or during a war being likely to damage the moral force, and to shake the confidence of the troops.

In order to arrive at true tactical formations, the effect and power of fire must be truly estimated, otherwise false tactical formations are sure to be employed. Our own tactical formations up to the present time have been based upon the fire of the Napoleonic period. What was this fire? Infantry fire slow, very inaccurate; effective up to 200 or perhaps at most 250 yards. Artillery fire effective to about 1,500 yards, but shell power comparatively feeble, the greatest effect of artillery being really within the case-zone of, say 500 to 200 yards, before effective infantry fire was reached. Under these conditions we saw foreign troops attacking in such formations as that of Macdonald's column at Wagram, consisting of three divisions, one of which had its battalions deployed in one great column, the others being in contiguous columns of battalions on the flanks; or as D'Erlon's columns at Waterloo, four divisions each advancing in column on a front of a deployed battalion; or as Ney's right column at Friedland, with a front of some sixty-six files, and a depth of about eighty ranks. Our own troops, using the line formation, at times two deep, and at times four deep, (in which latter formation both the Guards and 52nd Regiment moved at Waterloo to repulse the last attack of the French Imperial Guard,) passing through the skirmishers who ran in, advanced over the comparatively short distances which separated the contending bodies of troops, and fired upon the enemy. The artillery, able to protect its

front with ease, advanced to positions often half way between the elaborately drawn up lines of battle, whence it could effect by short-range fire the demoralization of the enemy necessary to allow a successful infantry attack, and then advanced when possible with the infantry. Witness Ney's advanced battery of 80 guns at Waterloo, Lauriston's and Drouot's batteries of 100 guns at Wagram, and Senarmont's wonderful advance of 30 guns at Friedland.

But how would these tactics suit the weapons of to-day? Let us look at the enormous change in the fire of artillery and infantry. Look at these diagrams,* for which I am indebted to Captain W. H. Noble of the Department of the Director-General of Artillery, and which represent the effect of artillery fire on columns of troops lying down. The dotted rectangles represent battalions in quarter-columns; the firm-line rectangles battalions in double company quarter-columns. Ten shots are fired from a 9-pounder gun, the field gun of our service. At a range of 3,292 yards seven out of the ten will strike the battalion in double company column, nine of the ten would strike the battalion in quarter column. At 1,176 yards we find the whole of the shot falling within the battalion quarter column.

Having thus seen the effect of fire upon battalion columns, let us examine this table,† showing the effect of artillery fire on lines of troops; and I would here observe that we have recently developed a projectile, shrapnel shell, the full effect of which has never yet been seen in war, even in the war of 1870; for the Prussians had no shrapnel, and the French had only shrapnel of an indifferent nature. Look how great, even at the range of 3,000 and 2,500 yards, is the effect of shrapnel upon the lines of troops. Make what deduction you will for the extra height of the target, yet you must admit that the effect of the fire will be terrible.

I have here also a return given to me by Colonel Bythesea, the Chief Instructor of the School of Musketry at Hythe,‡ showing the effect of infantry fire upon troops in various formations, which well deserves your careful attention.

Now, I am thoroughly aware that these returns, both of infantry and artillery, do not really represent what takes place in battle, because we never get anything like this accurate fire in consequence of the excitement and the smoke, and the difficulty of laying guns correctly in action. But still they do show us what an enormous power this fire possesses as compared with the fire of the past; and we must remember that it is not only in range and accuracy that the infantry has gained, we must think also of the immense development of rapidity of fire.

If such results as these could really be obtained in battle, it is not too much to say that troops could not move under fire, or that if they attempted to do so, they would speedily be annihilated. But the actual

* See Diagrams, Nos. 1, 2, 3. The battalion is supposed to consist of 800 men, divided into 8 companies of 50 files.

† See Table No. 4.

‡ See Table No. 5. The return was prepared at very short notice by Serjeant-Major Reid, and does not pretend to scientific accuracy.

results are so great that the front of a position held by troops in good order is, *so long as those troops are not demoralized by fire*, practically unassailable by troops in any close formation, if the attacking force has to pass over open ground, as we may fairly assume it will always have to do for a greater or less distance.

I want to show this by some examples; and here I would venture to remind you that as the British Army is without practical personal experience of the effect of these modern weapons in battle, we must borrow from the experience of other armies. Of all those armies the Prussian has had the greatest experience, and we can study both that experience and its results in detail; and we may learn much from the experience of the Austrians in 1866, and the French in 1870. None of these nations attempted to attack in these wars in the dense column formations of the Napoleonic period, but both Austrians and French did attack in line, and the Prussians did at times use whole battalion columns and lines of smaller columns in close order, half-battalion columns and company columns.

Let me give only a few examples. Take the battle of Gitschin, in 1866. On the Austrian left at one important moment a Prussian battalion in battalion-attacking-column endeavoured to debouch from the village of Unter-Lochow against the Austrians, who, only armed with muzzle-loading rifles, were holding the edge of a plateau to the east. The Prussian troops had to advance over quite open meadow land. They found themselves completely unable to continue the attack. They advanced some distance, but suffered tremendously. The men became demoralized, and at last the battalion had to lie down on the open ground, while its leading ranks endeavoured to keep up fire against the Austrians on the plateau.

On the Austrian right, at perhaps the most critical period of the battle, when the Prussians had unduly extended their left wing, and had only one single battalion left in reserve behind the village of Podulsch, six Austrian battalions advanced from Tetschin, three of the battalions directed against Zames and three against the village of Diletz. The three Austrian battalions directed against Diletz advanced in two lines, covered by skirmishers. Two Prussian companies were placed in the orchards to the north-east of the village, supported by another company, and later by the skirmishers of two other companies, making altogether less than a battalion. The Austrians advanced in two lines with the utmost gallantry. At 350 paces they were received with a volley and then with independent firing, and though they continued moving, and were one of the very best regiments of the Army, they were forced, before they got nearer than 150 paces to the enemy, to fall back, and so demoralized that they fled at full speed. At the same time two battalions advanced in line against the village of Zames. That one single battalion left in reserve was sent to repel this flank attack, which would have been fatal to the Prussian success. Two companies reached the village, and repelled the Austrian battalions by their rapid fire.*

* Compare Austrian and Prussian official accounts of the campaign of 1866. To avoid using several maps, I took examples from the battle of Gitschin only. Nachod,

Take now some examples from the war of 1870. There is that well-known example,—it is not necessary with such an audience as this that I should describe it,—the Prussian attack of three brigades upon Saint Privat. They advanced with skirmishers to the front followed by the supports, and the remainder in two lines of half-battalion columns.* Those half-battalion columns are only six ranks deep, and what was the result? Even if the losses be not so great as the Duke of Wurtemberg tells us,† if the Prussians did not lose so many as 6,000 men out of 18,000 in ten minutes, which he tells us they did, we know that they were utterly unable, advancing over the open ground, to keep up the attack. And there is another example which I brought forward on a previous occasion in this Institution, to be found in Lieut. Maurice's Wellington Prize Essay‡, the advance of the 93rd French Regiment at Rezonville, when under only the artillery fire of a battery of 24 guns at 2,000 paces the regiment suffered so terribly in its attempt to advance in line that it was utterly unable to maintain the attack.

What was the effect of this experience on the Prussian tactics? Whereas in the infantry instruction book in use previous to the war we find, "The attacking column is the foundation of the fighting formation "for the infantry, as it is equally adapted to the order of battle for "attack, to the retreat when threatened by overpowering cavalry, and "for movements, etc. It unites in itself independence, strength, and "mobility, and it is therefore a fundamental principle that, as soon as "a battalion prepares itself for battle, it assumes this formation, with "the shooting sub-divisions in rear;"§ we find in the alterations in the instruction of infantry, issued after the war, "On account of the "intensity of the effect produced by fire, deep tactical bodies, such as "battalion columns, are not adapted to remain closed within reach of "artillery. Even half-battalions do not afford considerable advantages "in respect to reducing the breadth of the object of aim and increasing "the mobility."‖ And again, the very latest order, issued last March, commences, "When actually under the enemy's fire, the employment of "battalion columns can only be justified by special circumstances. "The normal fighting formation of the first line is therefore to be in

Skalitz, Trautenau, Kœniggrätz, would all have afforded equally strong proofs. The large map of Gitschin (drawn by Serjeant-Major Porterfield, R.A.) used at the lecture, is not engraved here, as so many maps of the battle field have been published. Since delivering this lecture, I have been studying these attacks on the battle field itself. There, on the ground, one is struck with admiration at the gallantry which the Austrians must have displayed in the unsuccessful attacks on Diletz, as much as at the skill in adapting formations to ground which the Prussians must have used when they wrested the same village from their enemy.

* This is the formation given by Borbstaedt, who may, I believe, be considered a trustworthy authority for what took place on the Prussian side.

† "The System of Attack of the Prussian Infantry in the Campaign of 1870-71," by Lieut. Field-Marshal William, Duke of Wurtemberg. Translated by Captain C. W. Robinson, p. 17.

‡ "Wellington Prize Essay," by Lieutenant F. Maurice, R.A., p. 29.

§ "The Regulation Drill of the Prussian Infantry," translated by Col. Newdigate, p. 143.

‖ "Latest Alterations in the Regulation Drill of the Prussian Army," translated by Col. Newdigate, p. 32.

"company columns."* In other words, the battalion unit is recognized as too large, and its fourth part is established as the real unit, the moment the enemy's fire is reached.

Having established this, let me read another sentence from the orders of 1871:—"Our infantry, well instructed in shooting, may repulse by "their fire every attack *in the front*, even of the most daring foe. The "conviction must be aroused and fostered in the infantry—that it is "unassailable in front, and has only something to apprehend when it "turns its back. An infantry, whose flanks are covered, not troubled "by losses caused by distant fire, opposing a *sang froid* volley fire to "the direct assault of the enemy, is invincible. The security of the "flanks is of great importance, and the further back the supports of "the first line are kept, the better will this object be attained."†

Here, then, is the absolute power of front defence recognized, as well as the necessity for small units, as soon as under fire, in moving to the attack. The same instructions recognize the weakness of the flanks, and the necessity of securing them by adopting a formation with supports kept far back to repel flanking movements.

Now having abolished, for fighting purposes, the battalion and half-battalion columns, the Prussians substitute company columns,—small bodies moving in formation only four ranks deep if the skirmishers are out, or at the most six ranks deep. And here let me call attention to what this company column of the Prussians is.‡ When its skirmishers are not out in front of it, it consists of three lines, each of two ranks, and when its skirmishers are thrown out, it is nothing but the line four deep, with which our Guards and our 52nd Regiment repulsed the French advance at Waterloo.

Having substituted "a flexible chain for an iron bar," an elastic line capable of seeking cover far better than a mass or a whole battalion in line, in what formation do these troops advance to fight? The fighting is carried on by what we call the skirmishers, and what they call the shooters; the bodies in rear become practically only reserves from which to draw troops to feed this shooting, fighting line. This is what the Prussians say of it:—"Fighting in skirmishing order will predominate "even to a greater extent, and the closed divisions will act almost "entirely as reserves. They should offer the means of fostering the "shooting fight, and must frequently adhere closely to its course in "their movements."§ And mark how these bodies advance so as to make use of shelter. Perhaps I cannot better explain this to you than by reading what Major Tellenbach says in his pamphlet on "The Art "of Operating under the Enemy's Fire, with as little Loss as possible." "The chief maxim in utilizing cover should be—That the attitude of "each individual man, and the formation of troops, must be in conformity

* Beyond the debt which, in common with the rest of the Army, I owe to Colonel Newdigate for his published translations, I have to thank him for sending me a MS. translation of the Prussian order of 24th March last, immediately after its appearance in the Militair Wochenblatt.

† Latest Alterations, p. 22.

‡ See Diagram No. 6.

§ Latest Alterations, p. 31.

" with the cover at hand, and change with the character of the ground. " Let us first consider ground which gives cover to a brigade in rendez- " vous formation, the brigade should move forward in that formation so " long as it has cover. If the ground changes, and the brigade no " longer finds cover, then it must spread out its battalions. In what " way? Exactly as the ground prescribes. Perhaps two battalions can " remain together, either behind or beside one another. Perhaps one " battalion must separate itself 150 paces from the battalion of direction, " the other 50 paces. Perhaps one battalion must move out beyond " the line of direction; the other remain behind it. Perhaps for one " battalion, the line formation may be advantageous, for another the " column, and a third may most expediently move forward in company " columns, or in yet more scattered formation; or the second line must, " even for a moment, double in with the first. If the ground alters, " the formation must alter."* And the principle is carried out into the company columns.

Look at this normal formation for the advance of a battalion.† The battalion forms company columns towards the centre. Two flank companies advance to fight. Each throws out half a shooting zug; that is followed by the other half, and then as a reserve follows the rest of the company column which is nothing but a line four deep. In rear, again, there is the second reserve or the main body, ready as a reservoir, from which to feed and to supply any want that may be felt in front. Now, see the gradual diminution of these bodies as the front is reached. And, let me add, the subdivision of command goes even further than the half zug, and there is a division into sections (and I believe this to be a most important point) of not less than eight or more than twelve men, each under a separate command.

Now, in what order will these troops fight? Suppose a fight opened by the skirmishers, how do the supports move? The last order is very distinct—"The troops in support may follow the shooting line in line or column"—that column being zugs—"half-zugs or sections, and, quite as an exception, also in file." In other words, there is no formation that you can imagine in which these troops may not move. And these rear bodies,—and, if we carry our illustration still further to the brigade, where we have three battalions acting in the front line and three battalions in second line, 400 yards or so in the rear,—how do these rear bodies move?‡ "Where the enemy's fire renders it necessary, " the *treffen* (bodies of troops) in rear must also assume an appro- " priate formation in order to lessen its effects. It may, therefore, be " suitable that these *treffen*, or certain of them, form wholly or partially " in company columns or in line. The companies may also deploy

* Upon the Art of Operating under the Enemy's Fire with as Little Loss as Possible," by Major Tellenbach. Translated by Capt. C. W. Robinson, p. 11.

† See Diagram No. 7.

‡ See Diagram No. 8. In this diagram each battalion is shown as covering 400 paces of front: that being the front suggested in Colonel Schellendorf's "inspired" reply to Captain May's pamphlet on the Prussian infantry, in 1869. The idea that a battalion when fighting only occupies exactly the same front which it would occupy if drawn up in three ranks on parade, is apparently quite exploded in Prussia.

"into line, or break into *halb-züge* or sections."* For these bodies in rear again exactly that formation which is best suited for the ground is left to be employed.

What, really, does this mean? It means that each body, as Tellenbach has said, is formed to suit the ground. There is no rigid rule. But who is responsible for the formation which these supports should take? The Officer in command of each body of supports. Who for these reserves? The Officers in command of each body.

Now the fight progresses. This shooting line gains ground. It may be extended to a flank rapidly by the movement of the supports, supposing that there is evident opportunity for extension to a flank. On the other hand, it may require strengthening in the centre, and there may be room somewhere in the line for a greater body of fire. The supports at once become absorbed in the line. How? They extend, and they advance on the responsibility of the Captain commanding each company, and if they are in smaller bodies than companies, on the responsibility of the officer commanding that body; and other troops come up to take their place. As the first supports become extended, others move up to take their place. Each moves up to his place in the fighting line with the certain confidence that his place in rear will be taken. There is no fear of want of support, for each officer is trained to understand the progress of a fight, and he does not fear responsibility. He is brought up to accept it, and he is trained to used it aright. *Thus, then, this shooting line is the fighting line.* It no longer merely covers the fighting line as before, but, I repeat, it is the fighting line. Fed by small bodies successively brought up in extended order, their places as supports being taken by fresh bodies drawn from the reservoir in rear, the fighting line may be brought to great strength. Little by little, bit by bit, it has been fed by troops not in close formation. Little by little it has worked its way close up to the enemy, and by this feeding system of the shooting line a superiority of infantry fire is established, and the enemy's troops are demoralized. Now mark what this shooting line has become at the moment when the final attack may be made, when possibly whole battalions are absorbed into this fighting line. It is a line, but not a rigid line. It is a line depending on conditions of ground—a line which has worked its way to this point in small bodies, in fighting order, without that fearful loss and consequent demoralization which must inevitably ever attend the advance, or the attempt to advance, of a rigid line of anything like its strength. It has reached its point, and it brings an overwhelming fire to bear, having arrived at that point by the only possible method by which troops can be worked close up to the enemy's front. Then comes the final attack—the rush of this reinforced line—this fighting swarm, closely followed by the nearest supports. The Prussian instructions thus describe it:

"If the enemy's infantry appears to be shaken in its holding of any "part of this position, the shooting line with the nearest, but hitherto "concealed supports, rush forward in a quick and concentrated assault "upon this point; whilst these draw together in close divisions it must

* Extract from the Prussian Order of March, 1873.

" be the Officers' endeavour to get them quickly into hand, in order to " be able to resist the enemy's counter-attack. In the meanwhile the " divisions farther in rear follow up quickly."*

Such, then, is the system of tactics now employed for infantry attacks. It is based upon these two principles—recognition that the front of the position held by good troops is unassailable until they have been demoralized by the establishment of superior fire; and secondly, recognition that it is a useless waste of life to bring troops in close formation, except where there is shelter, under the enemy's fire.

Now, look for a moment at the advantage of this deep formation of successive bodies of troops. It gives the power of rapid support; the power of rapid extension to a flank; and flank attack, not only on a whole position, but partial flank attacks on part of a position become a consequence of the great difficulty of direct front attack. And see how the constant stream of further supports is kept pouring up from the rear to the front. See, also, how if the front line has to fall back, it falls back just like a system of outposts, on constantly increasing bodies of troops. It is sure of the ultimate moral support of closed reserves.

But now let us examine the conditions which seem essential to the success of this system of tactics. In order to perfect this system, there must be a thorough subdivision of the infantry into bodies of gradually diminishing size, each capable of independent action; for since fighting must be entered upon in extended formations, and fire is so heavy, and even the noise is so great, the difficulty of supervising a large body of men in the fighting line is vastly increased, while the necessity for careful supervision is increased also. Thus, the actual command in the fighting line must be in small bodies. Further out of fire, more men may be commanded, because the formations can be closer; but the superior command cannot be exerted over a wide front. It must be in depth rather than in width.

Again, in order to success, there must be the most thorough tactical training, not mere drill training, but tactical or fighting training. Theory must do something; actual fighting instruction must do more; for this system depends, I acknowledge it, on the skill of the officers commanding small units, on their coolness, and their knowledge of how to act under all conditions. They must act on their own responsibility, and that is so well put in a letter written to me by Lieutenant Maurice, on sending me a copy of his Wellington Prize Essay, that I venture to read it:—" I think, when you have read my essay, you will see " what I meant by saying to you that the cultivation of a habit of " independent action is our great tactical necessity. I quite agree " with you that it is a necessity in everything: but what I mean is " this,—make the question as dryly one of mere manœuvring facility as " you will, limit it to the mere mechanism employed in the ordinary " definition of manœuvres, and in *that*, this freedom of action is, under " present conditions, the essential joint on which everything pivots. " My contention is, that since we have now to deal with an organism, " not a machine, its very freedom of motion depends on the nature of

* Latest Alterations, p. 27.

"the vital power which is infused into each limb." And look at the vigour—the huge reservoir of mental and physical power that we have as yet more or less untapped in this body of junior Officers in the Army, all full of activity, and eagerness, and courage, and, let me add, of desire for responsibility and desire for instruction. Think what an organism the Army becomes—no longer a mere mechanism, but an organism full of vital power in every limb. You know how the Prussians recognize this; you know how they meet it.

I hope to hear from those who oppose this system of fighting their objections in the course of the discussion after the lecture. I have only heard one or two. One is, they say that steadiness is lost in this system of fighting. Steadiness, they say, is the British soldier's characteristic; line formation suits it; therefore, keep to line attack. What is steadiness? Is it not moral force? Is it only to be had by keeping men in close order under the officer's eye? Was not the skirmishing of our light division in the Peninsula steady in the true sense? No one doubts the troops are more under control in line, but when, as I hold, and the Prussians hold, the fire of the present day is such as to destroy the steadiness of any troops in the world in a close formation at effective ranges on open ground, what becomes of the steadiness then? As a formation under some conditions undoubtedly line is the best. Stationary under artillery fire, for troops lying down, it is admirable, but as a fighting formation is it not fatal to the chances of the troops who try to use it in the attack? The Germans say 30 per cent. is the maximum loss troops will sustain without flinching.* Add what you will, out of national pride, for British troops; for the British lost 50 per cent. at Albuera. But are our troops better now than then? And is it possible to advance in line to close range under that fire which I have shown you, without far more than even that loss?

Another objection that is made is with regard to the mixing of troops; but is not this deep formation the very best security against the mixing of troops, for it is not until every man of the battalion is used up in a comparatively short front that any real mixing of the troops of another battalion may take place with them. And how was it with regard to the mixing of troops in our own fighting in the Crimea? It was but the other day that Sir Alfred Horsford said to me, when I was speaking of this question of mixing, "It must always take place. I commanded "a green jacketed battalion at the Alma, and very soon I had as many "red coats as green coats to command." And, Sir, sitting next to you is an officer who commanded a company of the Guards at Inkermann,† and I would ask him to tell us what is his experience of the mixing up of troops.

I now turn to an important question. There has recently been issued an order for experimental formations of the British troops, which is held by all students of tactics as the first great step to meet the necessities of modern fighting. The different formations for the battalion acting singly, for the brigade acting singly, and for the division, I have endeavoured to draw here as accurately as I can, working them to scale,

* See Laymann, p. 5.

† Colonel Stephenson, C.B., Commanding Scots Fusilier Guards.

from the order as it originally was given; * and I must point out at once that the difference of distance between skirmishers and supports, and supports and reserves, in the Prussian battalion and in the English, as shown in these diagrams, is simply due to the fact that these Prussian short distances are given for convenience of work on parade, and that the moment the troops pass to fighting in the field, these distances become extended to the same extent as our own. In fact, they depend entirely on the ground. Here we see in Diagram No. 9 the battalion first arranged in two half-battalion quarter-columns. Each sends out a company to skirmish and a company to support, and keeps two companies in reserve. Here we see the principle recognized, that the command in front can only extend over a short space, a half-battalion commander superintending in great depth these four companies. And here in Diagram No. 10 the principle is not recognized, for one half-battalion covers the front of the whole battalion. In this latter case the commander of the half-battalion has to superintend the fighting over double the front covered by him in No. 9.

Here in Diagram No. 11, of the brigade acting singly, our brigade being only three battalions, we have, in the first instance, the brigade drawn up in line of half battalion quarter columns, and then covering its whole front by one single battalion. That clearly is against the principle enunciated, that the command should only extend over a small front in the fighting formations of the present day. In Diagram No. 11, if you suppose the brigade merely to cover the exact space occupied by its three battalions in line, 875 yards, or half a mile, the commander of one battalion has to cover that front, while each of his half-battalion commanders would have to superintend the fighting over a front of a quarter of a mile. Here, on the other hand, in Diagram No. 12, we have two battalions formed as in No. 9, fighting side by side, as in the Prussian system, each covering its own front. There is here great depth of formation, and the principle is thoroughly recognized of the command being only over a small front.

In Diagrams No. 13 to 15 we have the division in two brigades. In No. 13, a single battalion acts in front of the whole division, and the difficulty of support in that case would, it appears to me, be excessively great; it seems difficult to know how the command is to be carried on over such a front as that. In No. 14, on the other hand, we have the two brigades side by side, each keeping a battalion back in the rear. We have thorough depth, and the command in the front line of fighting is well subdivided.

I hope there will be some discussion as to these formations. I bring them forward because the order is issued as an experimental order to be reported upon, and it must help any one who is to report to hear these things discussed by practical men. There are one or two points which strike me, about which I shall fearlessly speak. It appears to me that the essence of this modern system of fighting is, that responsibility should be extended to the commanders of the small units. I may be wrong;—but I do not see in these orders that the responsibility is allowed to extend beyond the commanders of the half-battalions. In

* See Diagrams 9 to 15.

the Prussian case, the commanders of the supports will move up on their own responsibility, and will change formation on their own responsibility, and the officers commanding bodies in rear will follow on their own responsibility. I do not think that that is recognized in the English orders. I shall be corrected by infantry officers if I am wrong, but I assume that there is no such responsibility here contemplated as that allowed to the captains of the Prussian companies in support, but that our captains have to wait for the order of the half-battalion commander. And, in the English orders, only two kinds of formation are allowed; one is line, and the other, line with open files, a yard apart.

If I may venture an opinion, this extension of responsibility must come, and the first thing to be done is to train the company officers in fighting, and the men in fire-discipline and in fighting-discipline. See how strong the Prussians are on this point. "In the above "rules, the demands of modern fighting have been taken into account. "I must, however, expressly draw attention to the following, that in "the instruction of companies, battalions, regiments, and brigades, Sec-"tions . . . . of the Regulations have to receive increased attention; "so that the multiplicity of units and the development of strong lines of "skirmishers do not lead to a disastrous loosening of the tactical "combinations. This danger can only be effectually opposed by an "intimate knowledge of the fighting formations on the part of the "Officers, and by a high degree of fighting- and fire-discipline, combined "with a well grounded and strictly carried out school drill."* I know the enormous difficulty that is introduced owing to the inability to use ground for fighting-training because it is in private hands; but this must be met in some way, if our Army is to learn how to fight under modern conditions; it must either be met by an Act of Parliament or the purchase of a large tract of available country for the establishment of a fighting school. And then, with this training, I dare not say before it, must come the extension of responsibility. Then we shall be able to "infuse that vital force into every limb." It is dangerous until there is the knowledge on the part of the officers of junior rank; it is dangerous until they have that power of control which they must get. Without that knowledge on their part, the troops would be badly employed, and defeat would be the result.

The same training is equally necessary for the defence as for the attack. To begin with, defence is never, or ought never, to be purely passive; it must pass at times and at various points into attack; and moreover, these same principles of deep formation prevail equally in defence as in attack. A position with clear open ground in front, such as gives the fullest opportunity for the exercise of modern arms, being chosen, this is how the Prussian instructions say it should be occupied:—"The strength which the front of infantry possesses through "the increased efficacy of the fire, points to the attack upon the flanks "as the weakest point in the fighting line. To obviate this danger in "the defence, a deep formation is especially appropriate. Divisions

* Extract from Prussian Order of March, 1873.

"kept in rear which are moved forward to the side, without even "moving into the proper line of fight, flank on their side the flank-"ing attack of the enemy. In a close country especially, suitable "divisions (companies or subdivisions) must be kept in readiness for "this in the rear, near the flanks of the firing line, as much con-"cealed as possible."* Time completely forbids it,—but if I had time, I would have shown how it is contemplated by Moltke to carry out this principle of deep formation in bodies of troops of all arms acting together—holding a front by comparatively small bodies of troops—and keeping the reserve far back, ready to move on the radius towards the threatened flank where the enemy who is to attack must pass round the circumference of which the radius is the defender's effective artillery fire.†

And now, although my lecture is on the tactics of the three arms, I do not propose to speak of cavalry. Colonel Baker has recently so ably treated that subject, and I agree so thoroughly with him that the *rôle* of cavalry is not now, as formerly, except under very rare conditions, to attack in masses in battle, but, that which demands far more intelligence and courage, to be the screen, the eyes and ears of the Army, that I do not propose to enter upon cavalry tactics, but will pass at once to artillery.

I must here touch on the question of attack and defence. How is it that, while the defence is apparently so enormously powerful, the attack ever succeeds? How is it that the attack is often held now by many tacticians to be still more powerful than the defence? Because of the power of the assailant to choose his point of attack, to concentrate his fire upon it, and to choose his moment of attack, while the defender must guard the whole position and really only knows at the last moment when or where the heaviest attack may take place. It is distinctly recognized, and were it not so, experience of these wars would establish it beyond question that in order to attack a position held by good troops with any chance of success, the attack must be preceded by long continued, and above all, accurate artillery fire. The attempts to attack positions without such previous fire led, especially in the wars of 1866, to losses out of all due proportion for the work done, and to failures in the attack. Nor indeed, in 1870, was it otherwise. The Prussian official account points to this as one of the chief causes of the heavy losses at Spicheren. It was undoubtedly so at Saint Privat; and subsequently it was the artillery firing chiefly which demoralized the French holding that position. I was told by the Officer commanding the Sixth French corps, who was familiar with what had taken place at the Alma, Inkermann, Magenta, Solferino, and Rezonville, that even he could not have imagined such a hail of artillery fire as there was in the position at Saint Privat, and that only the bravest men could stand long under it.

Now in those duels of artillery which precede attacks there is ample

* Latest Alterations, &c., p. 29.

† "Observations on the Influence that Arms of Precision have on Modern Tactics:" by Field Marshal Baron von Moltke. Translated by Lieutenant Craufurd, R.A., p. 17.

proof of the immense value of getting the initial superiority over the enemy's artillery. This belongs essentially to the defence in the first instance; for the defenders are in position and they can at once bring fire to bear upon any artillery showing itself, while the artillery of the assailant must be brought up in succession from the line of march.

There is, for the assailant, only one chance of meeting this, and it is to bring up masses of artillery early into action, to lose not one moment in inaccurate fire, or diverging wasteful fire, but to commence at once a heavy fire of many guns, accurate from the beginning, and at once concentrated on that one point which is most immediately important. This, then, requires three distinct conditions for success. First, that artillery must be near the head of the column of march. I do not dilate on this. I believe it is fully recognized as a tactical necessity. Prince Hohenlohe brings it out very strongly in his pamphlet. It is a matter of vital importance, and for the details of working out the position of artillery on the line of march I would refer to his work.* Secondly, the power of accurately and rapidly judging range and of firing with great accuracy. A good range-finder, and, in its absence, careful training gives the first. Careful training alone gives the second. And here I would urge the intense importance of making accuracy rather than rapidity of fire the tactical aim of artillery. Artillery, like infantry, is apt, under the excitement of battle, to fire hastily. Every shot so fired does more harm than good. It is so much ammunition brought up at great labour, and which may be badly wanted later, thrown away. Thirdly, thorough system of artillery command, so that guns may act with one object and not with various objects: may concentrate their fire and not scatter it, and that this object and this point of concentration may be such as best meet the requirements of the officer commanding the whole body of troops. This demands that an artillery officer should be in command of all the artillery of this body, whatever it be,—advanced guard, division, or corps,—that he should be with the Commander in the reconnaissance of the position, learn from him what he wants done, and then be responsible to him for its being done. Now this responsible task the Commanding Officer of artillery can only thoroughly carry out by himself superintending the action of his artillery, by supervising its action, not so far as to interfere with battery details, but giving such general supervision as will insure that the action of the batteries is in accordance with the plan confided to him. The battery commanders cannot all know the General's plan, hence their action must be confined to the carrying out of the orders of the commanding officer of artillery, for if they are allowed to choose their own objects of fire, scattering will be the inevitable result in lieu of concentration. Hence the great value of massing artillery. It acts with one object under the command of the officer commanding the artillery, whereas, if batteries are dispersed, the orders take much longer in transit, and it is almost an impossibility to prevent battery commanders yielding to the tempta-

* "On the employment of Field Artillery in combination with the other Arms:" by Kraft, Prince of Hohenlohe Ingelfingen. Translated by Captain F. C. H. Clarke, R.A., pp. 28—32.

tion to fire on bodies of troops in their own immediate front, their fire being thus lost so far as the general plan is concerned, the preparation of the important attack being delayed,—and such delay may be fatal.

Now, I know the argument against such massing, and in favour of separating batteries while concentrating fire. It is said that massed batteries afford a larger target than single batteries. But a single battery offers a front of 100 yards, and if artillery and infantry cannot hit a target with a front of 100 yards, it will be no use in the world to give them a wider one. If the argument were that it is better to keep single guns apart, I grant that a gun is a small target to hit, but I take it that there are no advocates for the separation of single guns. Another argument against massing is the question of oblique fire. It is said that oblique fire can be brought to bear on massed batteries by dispersed batteries. Now, if you will look at this diagram,* in which six batteries are placed against six batteries, 2,000 yards apart from centre to centre; where, on one side, 36 guns are massed over a front of 720 yards, and on the other side there are intervals between each battery of twice the front of the battery, the 36 guns thus covering a front of 1824 yards, you will see how very small, even in this case, is the advantage gained by oblique fire. And what would really happen in such a case as this? The commanding Officer of the 36 massed guns places himself with his telescope in rear of the centre of them. He has only 360 yards to each flank of his guns. He can despatch an order, even to his flank guns, in a minute. He says to his whole mass of guns, "First wipe me out No. 1 battery of the enemy;" then when he sees that a few rounds have had their effect, he says, "Wipe me "out No. 2 battery;" and so on in succession. Now, would it be possible that the opposing batteries, separated by intervals of front of two batteries, could possibly act with this simultaneous action? There would be a distance of more than half a mile from the centre to either flank.

It is, I believe, to this massing of guns and their consequent unity of action that the Prussians owed their great artillery success in the campaign of 1870, as well as to their great accuracy of fire. Colonel Smyth's paper, in the Royal Artillery Institution proceedings,† brings this out plainly enough. The account of the action of the 84 guns of the VIIth corps at Gravelotte, shows how the guns were handled. And read Frossard's tribute—the tribute paid by the Officer commanding the troops opposed to that battery. He says, "This artillery "had the advantage over us, not only in number of guns and in range, "but, why should I not admit it, in accuracy of fire. We could not "but remark their care in choosing positions suitable for their artil- "lery, in sheltering it from our sight, in rapid construction of shelter, "and finally in provoking, by a few apparently timid trial shots, our "guns, so that they ascertained the position and strength of our "batteries and then brought to bear on them a vastly superior number

* See Diagram No. 16.

† Proceedings of the Royal Artillery Institution, February, 1871, vol. vii, pp. 184, &c.

"of guns. In short, they did all that our artillery equally knows "how to do, but does not sufficiently practice."* It was by the fire of their massed artillery that the Prussians demoralized the 6th Corps at Saint Privat. Once this initial superiority gained—a superiority of artillery fire established—the enemy's infantry movements are nipped in the bud, as for example, that attempt to advance of the French 94th Regiment, which I have already described, at the battle of Rezonville.

A word on the choice of position for guns. Over and above the questions of shelter, clear view, and nature of ground, which every artillery Officer ought thoroughly to understand, and which are not much affected by modern changes, there enters a new element into the choice of position and also into the conduct of fire. From a study of the battle fields of the late war, I am thoroughly convinced that, except perhaps at the very opening of an action, when artillery has come into action before other troops, it is now almost constantly firing over the heads of its own infantry. At Woerth, Weissenburg, Spicheren, Gravelotte, Rezonville, it was certainly so, nor can I conceive how under the present great distances apart of guns and of the original formations of troops, it can possibly be otherwise. Artillery comes into action at, say, 2,500 or 2,000 yards, and even if later it advance at the sacrifice of thorough knowledge of range, and also of time, still it cannot advance with its infantry at a few hundred yards from the enemy right into the zone of effective infantry fire. Is it then to cease firing, because its troops have got within 800 or 600 yards of the enemy? What is really the danger? Study this diagram† which Colonel Owen has been so good as to work out, and if you admit that troops are safe when the projectiles pass 24 feet clear over their heads, then at a range of 3,000 yards, artillery may fire till its infantry is within 73 yards of the enemy; at 2,500 yards till it is within 103 yards; at 2,000 yards until within 153 yards; and at 1,500 yards until within, say, some 400 or 500 yards, for although the projectile is only 30 feet high at its highest point, the trajectory is very flat. Will not the point to which it is desirable to advance our guns be greatly regulated by the opportunity it affords of firing over the heads of our own troops? Come too near, and a flat trajectory prevents our firing safely over them, but well chosen positions may very much aid the power of continuing fire. Whether to advance at all from the first position, how far to advance, and in which direction, will be a point for the decision of the artillery officer in each individual case, bearing in mind the vital importance of keeping up the fire to the very last moment.

To what extent artillery can hold its own against infantry, is a point I should much like to hear discussed. If the infantry gets within fair range, say 600 yards, I am inclined to think that unless the guns are very well sheltered, they would soon be shut up. I could cite cases where, at various ranges from 800 to 400 yards, guns were compelled to discontinue firing; on the other hand, there are cases where they

* "Rapport sur les opérations du Deuxième Corps de l'Armée du Rhin, dans la Campagne de 1870:" par le Général Frossard, p. 116.

† See Diagram No. 17.

continued, though suffering desperate loss. The chief danger for the guns is when they are detached to the front, or are on the extreme flanks of the line. In other cases, they have for an escort the whole body of infantry fighting in their front, but when on the flanks, or detached to the front, they need an escort, cavalry and infantry if the ground is open, infantry only if the country is close—an escort not near the battery, but pushed out like outposts far to the flank to prevent the possibility of even the smallest body of infantry creeping up to within effective range. At Gitschin some Austrian heavy guns which took up a position in front of Zames were obliged to retire in consequence of hostile infantry having crept up the Cydlena valley and opened fire at about 400 yards.

That, under certain conditions, it is the bounden duty of an officer to fight his guns to the last, even though their loss may inevitably be the consequence, I firmly believe. Those Austrian officers, who, protecting the retreat of the army from the battlefield of Königgrätz, fought their guns till nearly all their horses and a great portion of their men were killed, surely deserved better of their army and of their country than if they had, before the horses and the men were killed, retired at an earlier period from the field of action. And see how the Prussians, again, recognise this. Read the close of Steinmetz's report on the proceedings of the 18th of August:—"I must draw especial attention to "the deeds of the artillery. It repeatedly silenced the enemy's guns, "shattered his positions, and exhibited great coolness and determination "under musketry fire. Hasse's horse artillery battery deserves very "special mention. This battery, although it had expended its ammu-"nition, had lost all the draught horses but six (out of 36), and "more than half the detachment horses (28 out of 48), never budged "from its position."*

Our guns are said to be our colours; I would it were not so. When a battalion holds its ground to the last, and leaves its dead by hundreds on the ground, retiring a shattered wreck, still fighting, it is highly honoured. When a battery fights thus to the last, its horses are killed, its men so reduced that it cannot carry off its guns as the battalion can its colours. Why should it not share the praise awarded to the battalion of infantry?

Another question of importance is the conduct of horse artillery in large battles; whether horse artillery is not better employed in being pushed forward and taking part in the general fighting, like those 24 guns of the cavalry division at Rezonville, than by being kept back with the cavalry and probably getting little or no opportunity of action through the day.

Again, a point of importance is the necessity of securing a position once gained by infantry, by at once bringing up guns. The stress which the Prussians lay upon this is shown by their immediately bringing up two batteries to the top of the heights of Spicheren.

Finally, I should like to say a word on the importance of retaining an artillery reserve. Hohenlohe does not, I think, sufficiently bring this

* "Die Operationen der Ersten Armee unter General von Steinmetz." Von A. von Schell, Major am Grossen Generalstabe. Berlin, 1872, p. 131.

out. The fact is, that the Prussians were generally so superior, either numerically or by the quality of their troops, that they never had their flank turned, and really were scarcely ever afraid of it. But suppose it had been otherwise, could a flank attack be met without guns to meet it with? And I would here again draw attention to Moltke's suggestion for the occupation of a position by an army corps, and show how much stress he lays upon the importance of keeping back guns in reserve, to meet flank attacks.

I have already exceeded the time given to me; but these tactical questions seem to me of the most vital importance. If an army enters into war with false tactical formations, it becomes, as the Austrian army did in 1866, inevitably demoralized, under the repeated failures of its attacks. We have, I believe, a very grave responsibility on us in this generation. If we refuse to accept that responsibility fully, and to meet the requirements of modern war, history will in turn speak of us as it does of the Prussians, who were defeated at Jena, of the Austrians who were defeated at Sadowa, and of the French who were defeated at Sedan. I know that against my opinion and against that of the Prussians in these questions of tactics, there are Officers of high rank, for whose opinion I have an unspeakable respect. There may be some who would not dare to speak out plainly, because of the weight of opinion which they know to be against them. But, Sir, as you know, I have lived for five months in a land overrun by its enemy, and I have seen that which has placed in my mind so deep and so intense a sense of responsibility, that the effect of this knowledge upon me is not that I dare not speak, but that, as I have said to your Royal Highness on a former occasion, when the opportunity to speak is thus given to me, I dare not keep silence.

The CHAIRMAN: Gentlemen, I now invite discussion on this very important subject, and, as time is of importance, I am sorry to say, I propose to limit the discussion to an hour at most. I will therefore ask those Officers who are kindly going to speak to be as brief as possible.

Major COLLEY: The interesting lecture we have just listened to, has dealt so thoroughly with the principles and the requirements of modern tactics, that it leaves me little to say beyond expressing admiration for the clearness with which so difficult and complicated a subject has been developed, and assent to almost every principle enunciated. The lecturer, I am glad to say, has fairly met the question,—to my mind the most difficult as the most important,—of direct or front attack. There was a time immediately after the great battles of the late war, and especially after the appearance of the Duke of Wurtemberg's pamphlet, when it was commonly said great attacks could no longer be attempted, and flank attacks only could succeed against the new arms. But on an extensive battle field where large masses are engaged and the fighting line covers many miles, it is evident that a very small part only can attempt flank attacks; the great bulk of the force must be prepared to attack to its front, or remain practically inoperative. Moreover, the defender may have chosen a position unassailable on its flanks; or, what is still more probable, have sufficiently provided for such contingency, and may meet it by a counter attack, outflanking the turning assailant. Flank attacks are not such certain roads to victory as some suppose. Had the positions in the late war been reversed, and the French tried such manœuvres upon the Prussians, it is probable we should have had a very practical lesson on the dangers of flank attacks, such as Frederic read them at Rossbach once before. We must accept front or direct attacks as the rule, flank attacks as the exception; dependent not on ourselves but on the faulty dispositions of an adversary, and the very

fact that the front attack is now so difficult, is sufficient reason for studying and training for it the more carefully.

Now, the principal difficulty which presents itself, and which furnishes arguments to those who object to what may be called the new school of tactics, is that of combining the loose formations by which alone we can derive full advantage of our own fire and reduce the losses inflicted by that of the enemy—necessary conditions, as pointed out by the lecturer, of modern warfare—with the closer formations which are necessary to give weight, vigour, and unity to the attack. We must face the fact, that in proportion as we gain in the earlier stages of the fight by the more independent and intelligent action of skirmishers, do we lose in the vigour and unity of the last rush. Men once broken up as skirmishers, or pushed forward in small bodies and intermingled in the fighting line, will not push an attack home with the same unhesitating instinctive obedience to their Officers' word, as those who have never been out of his hand. Hence the compromise supported by a large school of experienced Officers in Prussia, and worked out in our new drill formations, of strengthening, indeed, the skirmishing line far beyond what was formerly the practice, and feeding it up to a certain point, but still keeping the greater part of the attacking force in close formation for the final assault. It seems to me that to decide on the merits of the rival systems it is necessary first to determine which is the most important period in the attack. Scherff, perhaps the ablest exponent of modern views on infantry tactics, and whose work has already acquired a European reputation—for I see it has been translated into French, English, Russian, and Italian—divides the fight into two phases, the preparation and advance up to a certain point, and the execution or actual rush. The requirements of these two phases are, as I have shown, to a certain extent contradictory; and if everything depends on the final rush, the advocates of close order have at least a very strong argument for keeping the mass of the attacking force in the formation most suited to that rush. In former times it unquestionably was so—the "preparation" was often very insignificant, and the attack was carried through by the moral effect of a vigorous and determined advance long before the defender had suffered such losses as to compel his retreat. It is interesting as bearing on this, to study the traditions of the great armies of Europe and to find that they all, like ourselves, believe the bayonet to be their own special weapon. They give one another credit for superiority in activity, manœuvring power, calmness, &c.; but in this one point, a bayonet charge, each and all consider themselves unrivalled. This is merely the expression of the fact that whenever two forces had arrived within a certain distance of one another, that one which had sufficient morale, sufficient go left in it, really to wish and try to close, was *ipso facto*, victorious; and that every army, therefore, could boast that whenever it had really made the attempt to cross bayonets, it had been victorious. In those days, therefore, it was right to sacrifice all other considerations to that of bringing up the troops in such formations as gave most promise of sustaining the morale of the assailants and of shaking that of the defenders at that critical moment.

We know that we cannot now attack in that way, that much more careful preparation is needed; but have we yet fully realised how much of the result belongs to the preparation, how much to the actual rush or last advance? Unfortunately, we have hardly yet sufficient data, sufficiently detailed accounts of the infantry engagements of the last war to enable us to judge truly. But there are, I think, strong symptoms that infantry fighting is constantly tending more and more to assume the character of an artillery duel—a pure fire fight; that two bodies approach to within a distance at which their fire tells with full effect, and that beyond that, neither party *can* advance until the other is not merely shaken but has actually given way; that in point of fact the retreat of the defenders has usually *preceded* the final advance of the assailants and has been determined, not by the gallant rush of a body of men, whether formed or unformed, but by the intensity of the concentrated, sustained, and ever-increasing fire brought to bear by a dense line of skirmishers constantly fed from the rear. We are perhaps a little apt to undervalue American experiences, and attribute to want of manœuvring power and energy of attack on their part, the indecisive results which were really due to stubbornness of defence. But certainly the battles of the great civil war bear out the opinions expressed by American Officers, that no advance can succeed against good troops holding a fair defensive

position till these have been not merely shaken, but practically broken and destroyed as a fighting body. If this is so—if the victory must be really determined by what we call the preparation, and the last advance does little but reap the fruits already won—then I think it is evident that the principles of former days must be reversed, and all considerations give way to that of feeding the firing line and so developing to the utmost, the true offensive power of the new arms.

With regard to our own proposed formations, as I understand them to be only experimental, I may perhaps be permitted to call attention to those points which seem to me open to discussion. I see it is laid down that for the final advance, the line is to advance *over* the skirmishers, the latter closing as soon as the line has passed, and forming a reserve. Now, I would ask those who have had the experience I have not had, whether at such a moment it is desirable to leave any one behind? If the position is to be carried by fire, the fire of nearly half the force is withdrawn at the most critical moment; if by assault, surely the advance should be made with every available man. If the skirmishers have done their duty and pushed up to decisive distance, a few seconds almost, in these days of literal storms of bullets, will suffice to decide the result of the attack. If successful, it will be time enough then to close the skirmishers; if unsuccessful, no half-formed skirmishers can save the retreat; the defeated troops can only throw themselves under the nearest cover, or be rallied on fresh troops. The skirmishers can only affect the result by joining in the advance. Another remark I would venture to make, if I may do so without being deemed presumptuous, is that neither in the formations as laid down, nor in their ordinary application, is sufficient attention paid to the flanks of the skirmishing line. So long as the skirmishers were a mere screen to the fighting body, it was quite right that they should overlap it. But if we admit the skirmishing line to be the fighting line, and that the duty of the formed bodies is to feed and nurse it, then they should pay especial attention to that most delicate point in such a line, its flank—and formed bodies in echelon on the flanks of the skirmishers would not only secure the latter against their chief danger, but would be in the position where their assistance could usually be given with most effect, and at the same time when their losses from fire would be least severe. I trust, however, that I shall hear these as well as the other wider and more important questions raised in the lecture discussed by more competent authorities.

General Lord DE ROS: It was the farthest from my intention to address the assembly of Officers that I have the honour to see around me; but with the greatest possible admiration for the able lecture of my gallant friend, and the manner in which he has delivered it, there are one or two things I cannot help being very much struck with, and on which I therefore desire to say a few words. In alluding to the responsibility necessary, which he thinks ought to be thrown, upon the junior Officers in action, he seemed to question whether our young Officers were sufficiently trained and acquainted with their duty to be trusted with this responsibility. Now, I know it is the fashion of the present day to say our young Officers are ignoramuses, and that they have everything to learn—that the French, Prussians, and Austrians are all greatly superior in education to our young Officers, and possess a far more extended knowledge of their duties. I entirely and wholly repudiate that idea. I have been more than 52 years in the British Army, and I never have known of a young Officer called upon in any position who did not fully respond to all that was demanded of him. I would not venture to put my opinion forward as conclusive, but I will refer to a remarkable statement made by the Duke of Wellington before the well-known military commission of the late Duke of Richmond, about thirty years ago. He said then that there was no army in the world whose young Officers were so capable of responsibilities as our own, and he cited as an instance that at the time when there were annual transportations of convicts to Botany Bay, numerous bodies of those dangerous and desperate people used to be sent out in ships in charge of one ensign and fifteen men; and the Duke stated most emphatically that there was no service on earth where that could be done but in our own. I must mention one other fact; on the Military Education Commission on which I had the honour to serve two years ago, no clearer evidence was given before that Commission than by His Royal Highness the Commander-in-Chief. With reference to the education of young Officers for the staff, we asked him if he had ever known a regimental

Officer taken out of his regiment and employed on the staff who had proved a failure. He said he never had known one single instance of that kind. As regards the responsibility proposed to be thrown on the young Officers in the field, my gallant friend observed on the danger of separate detachments of artillery taking upon themselves to act independently of the supervision of the Officer in chief command, who but knew from his position what was wanted to be done. Is there no similar danger if you tell young Officers that they are to be totally independent of their Lieutenant-Colonels and are to go here and there exactly as they may fancy the ground most suitable? Is there no danger of their going far beyond or far short of what was intended? I think there is great risk in this, and I also think it is quite impossible for Officers on foot to command more than 150 men in the field. I do not care whether they are Captains or Lieutenants, it does require the activity and wider view of the mounted Officer to command men in action to any extent. An Officer on foot, no matter how quick in his movement or how loud and clear in voice, is lost; nobody can hear him, nobody can see him at any distance, or in any confusion, and I cannot think that it would be possible to give this independence of command to Captains' subalterns unless they were mounted in the field.

Colonel HAMLEY, C.B., R.A.: I will only venture to say, after the admirable paper we have listened to, containing as it did so many interesting points, so lucidly set forth and illustrated, that there is nothing in it which appears to me more encouraging than what the lecturer has said of the experiments which are in progress relating to the adaptation of troops to ground. Opportunity of this kind is all that we want to conduct us to the most valuable results. As Captain Brackenbury has said, we have plenty of officers, zealous, able, intelligent, and, best of all, as I venture to think, young. We have plenty of men who are well versed in the theory of war. There are Officers now present who have former systems of tactics at their fingers' ends, and who have watched with the most intelligent interest everything that has passed in recent campaigns. As to strategy, I am convinced there are men among us who, if they had been required to form a plan of campaign, say for the invasion of France, in 1870, and had possessed the same facilities and advantages as the German strategists, would have evolved a scheme not less sound and complete than that which we have lately admired in the official accounts of the German staff. But in tactics, theory is of little avail, unless supplemented by the adaptation of troops to the actual circumstances of the ground. To those who very naturally cling to our old traditions endeared to them as they are by so many glorious recollections, and handed down through generations of zealous and excellent Officers, I would, in the face of impending changes in the system which they love, suggest this consolation. Nobody can say of that system that it was calculated to develop in a high degree the intelligence of Officers or of men. A regimental career of 20 or 30 years passed in the practice of such exercises as we are all familiar with, far from fitting a man for responsible command, rather tended to dwarf and to narrow him; its tendency was to reduce the man of resource, energy, and ability to the level of the dull man of routine. And therefore it was that many of us have seen Generals who appeared unable to rid themselves of their regimental recollections, and who, instead of fulfilling their proper duties, seemed to find their highest zest in that kind of supervision of their troops which is best left to the company Officers, or even to the sergeant-major. Now I think that those who, like our lecturer, advocate the changes he has explained to us, may claim for them that they *are* calculated to develop in a high degree the best qualities of all concerned. The problem of adapting troops to ground under modern fire is one that calls for ability, resource, and readiness. It will bring Officers into closer and more favourable contact with their men; it is more varied and interesting; it produces the most practical results, for instead of making the drill-ground a mere scene of empty show, where many of the manœuvres practised bear little relation to actual warfare, it makes it a miniature battle field. Seeing, then, that these changes must come, and that they possess so many compensations, the best that we can hope is that they may be accelerated, and that they may take place under the most favourable conditions. There is one other circumstance connected with this lecture, which I should like to advert to before I sit down, and which appears to me of excellent promise for the future. The chair is filled by a Royal Prince, who entered on his military career at a time when these new ideas were springing up and taking root

around us. He is absolutely free from the influence of those traditions which many of us have found it so hard to struggle with. His training has hitherto been of a thoroughly practical kind; I trust it may continue to be so, till he has passed through the higher grades of professional acquirement, and is fitted for command. And I trust, too, that if the opportunity comes, he may add fresh lustre to that name of happy omen which he derives from an illustrious godfather, and that he may vie with those warlike Princes of Germany who showed themselves such adepts in military science, and so sagacious in selecting capable men to aid and to advise them. This is no time to rest on traditions, or on the chance of discovering excellence which has been undeveloped by study. War is every year becoming more and more a problem to be studied. I venture to assure His Royal Highness that if, as a General, he should be in doubt or perplexity, or under the stress of momentous events, he will find, as those Princes found, firm supporters and able counsellors in those who have the most widely and deeply, and with the most open and unprejudiced minds, made a study of their profession.

Major-General M'DOUGALL: I am sure, Sir, we must all agree in the remarks with which Colonel Hamley characterised the lecture to which we have had the pleasure of listening. And we must all agree that the subject is one of the very highest interest and importance. The remarks that I have to make are of a general nature. In the programme with which Captain Brackenbury furnished myself and some others there is one proposition which he has ably supported—that a front held by good troops undemoralized is practically unassailable under the present conditions of fire. If this be conceded, then future campaigns will in all probability be decided rather by strategic than by tactical manœuvring. I may illustrate my meaning by quoting the following remark from a book published in 1864, recognizing the difficulty of advancing over open ground to attack even at that early period, immediately after the Danish war, when breechloaders first proved their value. "The "difficulty and uncertainty attending the assault of a position under the present "conditions will assimilate the strategy of every campaign to that which is the true "method of making war in mountains. The great art of a General, even in offen- "sive warfare, will consist in taking up such positions as, while they cover his own "line of retreat, will threaten the communications of his enemy, and so oblige the "latter to become the assailant." Now, although it is probable that this anticipation may to a great extent be realized in the future, it must be conceded that if the Prussians had been guided by that principle, they would not have gained the signal successes which they actually did gain, frequently indeed by a front assault on positions of great natural strength. It will be allowed, I think, that it is of great importance to the subject under discussion here to-day that the causes of the Prussian success should be rightly understood, especially in such a battle as that of Mars-la-Tour, where the French had all the advantages both in respect to position and numbers during the entire day; and again in the battle of Gravelotte two days afterwards, when the French position was such that at any time from early morning, when the Prussian turning movement commenced, up to 11 o'clock a.m., the French, had they taken the initiative, could certainly have brought a very superior force to bear against any point in the Prussian line of flank march which they might have chosen for attack. Now, the French troops engaged on these occasions were the best of the army, and from all I have been able to gather I feel in my own mind convinced that the causes of their failure were attributable partly no doubt, and also materially, to their extremely defective musketry training, but mainly and principally to the want of enterprise in their commander. The Prussian successes, therefore, on those occasions must not be taken as establishing the rule that it is wise or prudent to undertake the attack of strong positions in front, so long as any other course remains open for choice, the opinion of the Duke of Wurtemberg notwithstanding. In the remarks on the system of attack of the Prussian infantry in the campaign of 1870–71, published by the Duke of Wurtemberg, he says, "When, at "length, the news arrived of the brilliant storming of St. Privat by the Prussian "Garde—bloody though it was beyond precedent—which decided the battle of "Metz, now termed officially the battle of Gravelotte, there seemed to be no longer "a doubt that, even when opposed to the breechloader, the old charging tactics "formed the only effectual method of attack calculated to ensure victory." He

goes on to say, "The general voice of our own, as well as of the Russian army, "rejoiced that the old cherished system of charging in masses, which had been dis- "placed by the breechloader, had returned triumphant, and been reinstated in its "proper position." Yet almost in the next page he goes on elaborately to show that, owing to the very defective musketry instruction of the French soldiers, their assailants actually suffered greater loss when at a distance of between 1,200 and 1,800 yards than when they came to close quarters. The conclusion of the Duke of Wurtemberg that positions must in the future, as in the past, be carried by the old charging tactics, can only be accepted with reserve, because the conclusion is based on facts of an exceptional nature. But as no doubt circumstances must arise in which it will be necessary to take the bull by the horns, it is quite right that we should endeavour to ascertain the most prudent method of doing so. In the English service, the fighting unit is the battalion, and what we have to do, it seems to me, is to lay down the formation in which the battalion should advance to capture any part of an enemy's position which happens to be in its front. If we can arrive at this, I do not think there is any necessity for prescribing different modes of formation for a brigade according to the different number of battalions of which it is composed, because the tactics of a brigade will continue to be the same, and it is only the formation of the individual battalion that it is necessary to regulate. I believe that it will be found that a much slighter dislocation than is frequently proposed of our present drill system will entirely effect the object required. I hope it will, because I think anything like a great dislocation of an existing system is a misfortune. If we draw up a battalion in line at close order, the front, and the numbers of that line, represent the extent of front, and the numbers of the enemy with which that line will come in contact. For the actual contact, therefore, the attacking battalion would require all its men, and not only all its men, but all its men in close order; that is to say, all who may have survived to reach the enemy's position. The enemy's main position will no doubt—indeed, we may say certainly—be covered by strong skirmish line, and it appears to me that the main body of attack therefore must also be covered by skirmishers in the sense in which that term has always been understood. What formation that main body should assume in advancing to attack is the problem to be solved. The front of *attack* may be one thing; the front of *advance* may be another. The front of attack, by which I mean the front of actual collision, must be close; the front of advance, before coming into actual contact, may be open, the intervals being filled up by successive increments from the rear. But there are two points which are borne in upon me as being of great importance, which I venture to submit, Sir, to you and to this assembly, that whatever mode of advance we may adopt, if we adopt the open formation for advancing to attack an enemy's position, as it appears we must do, the feeding of the front of advance should always be directly from the rear; and that in no case ought troops, when under anything like an effective fire, to move to a flank, even for ten seconds, if it can possibly be avoided. I particularly allude to the description of what the Duke of Wurtemberg characterizes as the "concentric method of attack" in this pamphlet, which entirely fails to commend itself to my reason. I beg to submit those propositions to your consideration.

Major-General the Right Hon. Sir PERCY HERBERT, K.C.B.: As I understand General M'Dougall, he brings forward the battle of Gravelotte to illustrate the facility, not the difficulty, of a front attack. Now, I think the case tends exactly the other way. The enormous superiority of the Prussians on the occasion of the battle of Gravelotte has been entirely put on one side by my gallant friend. The superiority was very great indeed on that day. I do not allude to the battle of Vionville or Mars-la-Tour, where it was the reverse, but to the battle of Gravelotte proper. What was the crucial turning point of the battle? It was the second attack upon Marshal Canrobert's *corps d'armée*. The attack of the Guard at St. Privat was the greatest illustration that we have in modern times—I wont say of the impossibility—but the enormous difficulty of front attack over open ground upon troops that are prepared. When the Prussian Guard, in conjunction with other troops, renewed their front attack, what was the position of affairs?

1st. The German *corps d'armée* beyond St. Privat had developed their turning movement and flank attack against the French right.

2nd. The attack was upon Marshal Canrobert's corps. Now that corps was the last formed of the French Army. It was weak in men and incomplete in guns, having only 36 instead of about 80, and also in ammunition waggons.

It had been engaged many hours, and when the front attack was renewed, it was positively deficient of ammunition, and unable to keep up its infantry fire.

I say that that is a strong case in favour of the theory of the enormous difficulty anybody will have to contend against who attacks troops in open ground that are fairly prepared. Of course a case like that where the ammunition is exhausted in actual fight, is an exceptional case, and cannot be held to decide such a question.

Lieut.-Col. OWEN, R.A.: The remarks I shall have to make will be simply confined to the Service to which I have the honour to belong. In the first place, with regard to massing guns, I have always supposed, till about a couple of years ago, it was pretty generally acknowledged that massing guns when possible, was the established principle. Just before the late war, we constantly heard the expression used by military critics in lecture rooms and in the newspapers, that "fire should be concen-"trated, but guns should not be concentrated." Now we all know that principle is very true as regards siege artillery or artillery for coast defence; but when you come to artillery in the field, I am very glad to hear the subject is well treated by Captain Brackenbury and to hear the reasons so clearly given why it is necessary, in order to keep proper control, and in order to preserve the common object, and owing to the extent of ground required by a large force of artillery, that the guns should be massed as we have seen done during the late and some former wars. There are one or two points upon which I have certainly not always followed the advocates of the Prussians in the employment of artillery. One is as to pushing forward artillery on the line of march. I have no doubt, as you want to produce an effect at the beginning of an engagement, that is the correct principle; but under some circumstances, as when armies are operating in close and difficult countries, it seems to me it would be a very dangerous proceeding to press forward very large numbers of carriages and artillery which are practically helpless on the march, and which might lead to great disaster. I think I am borne out in that view to a great extent by what Colonel Hamley says in the third edition of his book recently published. There is another point which I was glad to hear Captain Brackenbury mention, and that was, that although it is considered necessary to push forward artillery at the commencement of an action, still it is extremely desirable to keep a certain reserve of artillery for a decisive moment. We are all aware of many cases when such a reserve has proved of great benefit. For instance, take the battle of Lutzen, where the Prussians and Russians had over 400 guns. The French had more than 200 guns less; yet by a wise economy of artillery at the early part of the action, Napoleon managed at the decisive moment to bring this force into play, and with the assistance of it, prepared the way for the infantry who decided that battle. Many other instances will occur to most of your recollections. There is another point, and that is the formidable power of shrapnel. There is no doubt we have never yet seen what can be done by shrapnel fire from rifled guns in the field and under favourable circumstances. The fire of shrapnel was advocated some years ago before rifled guns were introduced—very strongly advocated by Major-General Boxer, and a great number of experiments were tried to compare the effects of shrapnel with those of round shot, projectiles now of course utterly discarded. With regard to the effect of shrapnel fired over troops, it must, however, be remembered we have several very great difficulties to contend with which, I think, do not apply to the use of common shell. In the first place, you are obliged to use shrapnel, necessarily a weak shell, with a large charge that gives the shell a high velocity, or the effect of the shrapnel is very little. That being the case, there is very great danger of either the fuse or the shell itself giving way. And besides that, supposing the fuse is not properly set, or the burst of a previous shell in the air not rightly judged, you may get premature explosion not at the muzzle but very short of the object. Now, premature explosion of a shrapnel shell from a rifled gun would be a much more formidable thing than it was even from a smooth-bore gun; and I think we may comfort ourselves as to what we have recently heard of the French guns firing with velocities of 2,000 feet a second; and be assured that we have nothing out of the common to fear from such guns in service in the field. If these velocities are attained, the practical use of shrapnel will be

almost impossible. Very few shells and fuses would stand the charges necessary to give these high velocities, and if we look at the gunnery point of the question, I cannot see myself that there is very great advantage in these high velocities for field guns, as, besides increasing the chances of accident to gun or projectile, they make the regulation of the fuses and the practice at troops behind cover more difficult. I can mention an instance of the fire of shrapnel over the heads of troops. During the attack on the Redan, General Bormann, the Belgian Officer, states that the Russians, who gallantly mounted the parapets, were mown down by the fire of shrapnel from the left attack by the naval brigade. Perhaps you would excuse my saying that I remember from the 5-gun battery (right attack) doing the same thing myself at the proper left flank of the Redan. We fired over the heads of the infantry that were assaulting, though certainly it was rather a dangerous thing to do. You must remember, however, that the flank of the Redan was 200 or 300 yards beyond the salient, and it was slightly to the right. I mention that to show that shrapnel might have to be fired over the heads of troops, but only with great care; and I wish to point out that as common shell are not liable to premature explosion, and need not be burst short of the object, they are therefore safer projectiles for firing over troops than shrapnel. One other point I should like to mention is,—the execution that may be done with common shell, fired, as they do on the continent, with reduced charges, which is of some importance. There are many circumstances in which troops would be as safe from fire with large charges as they would in this room. In the attack of troops behind good cover of villages, and so on, it would be a very great advantage to fire common shells with reduced charges. The Russian, Prussian, and other artilleries carry a certain number of reduced charges besides the ordinary charges; and I cannot help thinking it would be a wise thing for us to do the same, in order that we might have the opportunity of reaching troops sheltered from any other fire.

General Sir William Codrington, G.C.B.: I should wish in a few words, notwithstanding the presence of many artillery Officers, to refer to the infantry, which I consider the principal arm of the service. I will incidentally mention the firing over their heads in action. As Colonel Owen has said, if there is a failure of shrapnel which is said to be most destructive against an enemy, if there is failure of a fuze, it is a very serious thing for your own advancing troops. Whether artillery could get upon the flanks so as to keep clear as much as possible of the line of advance, is a point that must depend upon the nature of the ground. It is very convenient for artillery to take up a position, say 2,500 or 3,000 yards in the rear; but it is a very different question for the men whose heads are fired over. In action I believe it is the case, and those who have seen more service than myself will be able to confirm it, that, in the midst of the row you cannot tell where shot are coming from, and men who are being fired over may feel that the shot may just as well be coming from the enemy as from their own people, particularly if there is the slightest idea of the failure of a fuse in your own shrapnel. But the main point is the tactical question with regard to infantry. I have heard the expression used, of "an extremely rigid line." I do not know why a line is, because it is a line, to be so very rigid. The very nature of the ground—take even Aldershot or any country like Chobham, where there are hills—the very nature of the ground prevents it being what is called a rigid line. Nor do I understand what very material difference there is between the principle of a battalion having skirmishers in front, with supports in rear, and then a column in reserve, which was at that time out of fire, and the new or the Prussian line of advance. There are equally, in both cases, skirmishers; there are, equally, in both cases, supports; and equally, in both cases, there is a reserve. Before the war, we saw in the Prussian manœuvres an immense deal of column movement, which, certainly, was erroneous; and we have seen that, in the war, that column movement produced the frightful losses at St. Privat, and, I think, at other places. The result has been, that the Prussian system that was supposed to be so good before the war, was, after the experience of the war, entirely done away with as to columns under fire.

Now, a word about the skirmishing. My impression, having seen a certain number of the Prussian troops skirmish in peace, is that they advance in rather close order, that is to say, at about three paces distance. If the supports, viz., the com-

pany columns in rear, which are really the feeding supports, come up into the front line of attack, what is that but the concentration of a line for attack? It seems to me that the very object and purpose of having those reserves, is to make a concentrated effort by line, and to do what the English Service did before, namely, to attack in line. I do not mean to say the same line will go over the distance now under infantry fire that it could formerly; it would be absurd to suppose so, but for the last effort you will not get skirmishers to succeed against a position where there is shelter and solid defence. It is almost acknowledged that such a position is unassailable in front, and yet skirmishers are supposed to attack this body that is under shelter and concentrated, and are supposed to succeed as skirmishers. I do not see that this is likely to be the result until you have brought up the successive supports so as to fill the intervals between skirmishers, thus forming that line to which objection is taken, but which you certainly do want to make a concentrated attack upon a concentrated enemy. I should rather like the lecturer to explain any difference between the Prussian system and the English system in that respect, namely, when once the troops are in immediate contact with the enemy.

Lieut.-Gen. Sir LINTORN SIMMONS, K.C.B., R.E.: It appears to me there is a distinction without any very great difference on this question of line. Captain Brackenbury has explained that at the moment of contact with the enemy, the attacking body is in line, and, moreover, in tolerably close line; the great difference seems to be whether that line is to be formed at a distance and moved up as a line, or whether it shall be moved up in small units, taking advantage of all available cover till they come in contact with the enemy. Captain Brackenbury gave a most lucid explanation of the manner in which the Prussians advance by their company columns, which, according to his description, are not columns in the sense in which the term is ordinarily used in England; they are small bodies, which can be readily thrown into line, or into any other formation, so as to take advantage of any accidental cover they may find in their front. The consequence is, that a battalion, instead of advancing in a regularly formed line, with a front of 300 yards, is broken up into a number of units; the Prussians break it up into four, we break it up into eight; and those small units are under the immediate control of their respective commanders, and can be at once thrown into any formation that may be preferable, without reference to superior authority, but subject to the instructions they have received as to the object to be attained. For my own part, I do not believe it is possible, since the introduction of breechloaders and rifled artillery, to advance a battalion in line from the distance at which it is now necessary to deploy until it comes in contact with the enemy. With respect to artillery fire, I think the experience of the war of 1870 is very clear as to the possibility and absolute necessity of firing over troops. In the attack on Saint Privat, which has been referred to several times, the Guards advanced, covered by a line of skirmishers, to within 400 yards of the village, with their supports and reserves in column behind them; when the advance was checked, the whole body, including the skirmishers, lay down without retiring, and the artillery fire was continued over their heads until the attack was renewed, when the French artillery had retired. Whether these latter were obliged to retire in consequence of the effect of fire, or of failure of their ammunition, I do not know, but the 72 guns were withdrawn before the Guards resumed their attack. Then at Sedan we have a remarkable instance which illustrates the Prussian system of attack, as well as any example during the late war. The 19th brigade, 5th corps, attacked between Illy and Floing with four battalions, two in the first line, in their usual formation, and two in second line. These battalions advanced against the position occupied by the French over ground which was entirely exposed throughout the whole of the advance. They went into a valley, and by the time they got to a small brook which ran through it, the front line had absorbed the supports. They advanced up the hill by successive rushes for short distances, till at length it absorbed the reserve. There was a still fresh rush, and by the time they came in contact with the French, the whole four battalions were in one line; and that is precisely the line adopted by ourselves. The thin line in which the British Army has always fought, which is often regarded as our national formation for battle, and one which is calculated to draw forth the best qualities of our soldiers. It is the manner in which that line is to be brought to the front in contact with the

enemy that appears to me to be the question at issue. To follow up that attack, the Prussians failed; they fell back a short distance under cover. Immediately the guns behind at very considerable ranges, 2,000 to 2,500 yards, opened with immense effect on the French on the hill. The French, notwithstanding, came over the brow of the hill three successive times, to drive the Prussians down. The Prussians repulsed them, and eventually succeeded in gaining a house on the top of the hill, and then the hill itself was carried. That is a good illustration of the manner in which the line is formed by the successive absorption of the units in its rear. With regard to what dropped from my friend Colonel Owen, as to artillery being in front on the line of march preparatory to a battle, it appears to me that this is an essential at present. The advanced guard, or the troops whom you may call the escort or supports for the artillery, should no doubt be strong enough to secure the artillery from being surprised either in close or open ground. On coming in contact with the enemy, the artillery at once comes into position with as great force as can be collected at the time, the stronger the better. I think the whole experience of the war shows that the attack of infantry must be prepared by artillery, and therefore unless the artillery is well to the front, valuable time will be lost in the preparation for attack; time so lost on the part of the assailants is time gained on the part of the defenders, and will often enable them to bring up reserves and defeat attack, which should therefore be prepared and followed up with the greatest promptitude. There is one point in connection with the diagrams exhibited by Captain Brackenbury of great importance to which I would venture to allude. It appears to me that the two systems of attack there shown differ very materially in principle. In the one (Diagrams Nos. 9, 12, and 14) the front of command, including the supports and reserves, in contact with the enemy, is reduced to 137 yards. In the other (Diagrams Nos. 12 and 13) it is 875 yards. But, Sir, these are full-sized battalions, or battalions of something like 800 men, whereas battalions in the ordinary practice in field manœuvres are 300 or 400 strong—rarely more than 400. Now, it is a totally different thing to cover a front of battalions of 400 men each, with skirmishers, from what it is to cover a front of battalions of 800 each; and experience with the smaller battalions may lead to a faulty system of working with the larger battalions; in covering the front of 400 you reduce the front of command in immediate contact with the enemy by one-half, leaving the Commander a front of 438 yards to observe, whereas with large battalions, when a whole brigade is covered by a single battalion, he has a large front, and I question exceedingly whether any man in immediate contact with the enemy can possibly control a front of 875 yards. As to the observation that we must depend upon horses, I think it is very questionable, in fact, I doubt whether any mounted Officer would be able to remain for any length of time in close contact with the enemy. In the figure (Diagram No. 14) there is a system of support from front to rear by troops who work together under the same Commander. The support moves up, and is absorbed in the line of skirmishers, or extends that line to a flank, according to circumstances, trusting to the Officer commanding in the rear, who naturally looks after his own men and their safety, to supply its place, or if he finds them out-flanked, to save them by extending on the exposed flank; whereas, in the other case (Diagram No. 13), the reserves belong to other regiments, and there may be a hesitation on the part of the Commanding Officers to break up their battalions and let them out of hand for a purpose, the object of which is perhaps not clearly seen. There is, therefore, a very great advantage in one man having to look after a certain limited proportion of the field. High education in war training is absolutely necessary, high education not only of Officers but of men; it must commence with the soldier, then extend to the Non-commissioned Officer who commands a small section, and so on throughout the whole chain of command. A very high degree of training is absolutely necessary. I have only to say I think Captain Brackenbury has dealt with the whole subject so fully, that we owe him our very best thanks.

Major C. B. Brackenbury, R.A.: Concerning the vexed question of front attack of infantry upon infantry, I would remark, as I have seen it actually carried out very often in war, that the great difference in principle between the Prussian practice in combat and our system of line is in the extent of carrying out the law of respon-

sibility. In the Prussian practice the system of responsibility is carried down even so far as to a couple of men skirmishing together; they are responsible, not to any great degree, but for their own lives and for the lives of such men as are behind them. Those men so working attain by habit to such a condition of steadiness in warfare that I have seen them again and again lift up their rifles and take aim and, when their enemy moves, lower their rifle without firing. Each man learns to hide himself, to take care of himself, and mark his enemy. In our line the men can only hide by word of command, and they are hardly able to take aim at their enemy. Colonel Owen spoke against artillery being near the front on the march. Now it is very certain that artillery and infantry encumber each other on the march. Artillery walks slower than infantry does, but its slowest trot is faster than the quickest infantry walk; the two arms therefore incommode each other. The general idea now is that wherever it is possible the main bulk of the artillery should march on a road parallel to that of the infantry, escorted by cavalry; and this is more possible than is usually supposed, because there are now so many roads. The lecturer mentioned one question which has not been touched upon in the discussion, namely, whether artillery is able to withstand the attack of infantry. It may be improbable that artillery can advance against infantry, but I consider it quite certain that a well-served artillery properly supported will resist the attack of infantry. One battery of six guns might not, but it is a very different affair when there come to be fifty guns in line; the enormous amount of fire then developed enables the huge battery to defend itself. Heavier guns can be used now, and a longer range is practicable if you have heavier guns. I may mention one fact told me the other day in France, that when the troops entered Paris in the time of the Commune, the Communists fired at them from a range of 5,000 yards, with Reffye guns, and the slaughter in the Trocadero was so great that the troops were obliged to quit the place. To make proper use of long range we must of course have accurate aim. A great deal of the new tactics of artillery must depend upon the extent of the zone which the guns are able to command. In many cases the guns in the front line will assume the power formerly only possible to the guns which waited in reserve, that is to say, the power of defending the flanks against attack.

Note by Major C. B. Brackenbury.—As the time named by Prince Arthur for the duration of the discussion had already expired when I was called upon to speak, I felt constrained to curtail the remarks I should otherwise have made. With the permission of the Council, I will add something in the form of a note, especially as Captain Brackenbury left England immediately after the lecture.

1. There appears to be a common misunderstanding as to what is the substitute proposed for the English form of line by those who deny the adaptability of the old formation to modern requirements.

The advocates of a development maintain that the fire of modern weapons is so deadly that no troops in the world can retain any formation whatever under its effects at close range delivered by an enemy who is either lying down or covered by accidents of the ground. It is not merely that the courage of the troops fails, but that the formation is physically broken up by the fall of vast numbers *in an extremely short space of time.*

It is plain therefore that the inevitable break of formation must be met in some way. The only question is—How? It would be demoralizing to consider the first line beaten and send another to take its place, suffering of course exactly in the same manner.

It is proposed to recognize the fact that the troops which arrive within charging distance of the enemy must do so in *open order*, better surely so than in *broken ranks*. The proposal is simply this. Let the advanced troops in open order—call them skirmishers or what you will—be considered as the fighting line. Let them use all the ingenuity to be found among Officers and men in covering themselves during their advance and gaining what ground they can. They are never to fall back on supports nor to expect a body of troops to march up from behind for their protection. But they are to expect that every foot they win will be kept for them as they push on, and that their numbers will increase by a gradual process of feeding from

The CHAIRMAN: As our time is up, I propose that the discussion shall end. I only hope I may be allowed to thank those Officers who have spoken, for giving us their able speeches.

Captain BRACKENBURY: There are one or two points on which I think I am bound to speak. Lord de Ros seemed to think that I cast a doubt upon the ability of the younger officers of the British Army.

Lord DE ROS: Oh no!

---

their friends in rear; and they are to be ready at any moment to seize a chance,—if the enemy is shaken or has his attention distracted by a flank attack,—a chance of rallying to any Officer who may call them and of charging home with a cheer.

If it be admitted that such a process or else failure must occur in war, it appears certain that it should be practised in peace, otherwise the men will feel confused by what will seem to them a fatal looseness. Hence arises the necessity for instituting a drill which shall teach steadiness in attacking upon the principles now stated,—principles not by any means adverse to that held by England when she set her lines against the Continental columns, but, on the contrary, natural growths from the root of the line idea. For the principle of the line was the development of a wide front of fire with comparatively slight exposure to the enemy's artillery. The system proposed carries these advantages a step further. The line required steadiness and discipline. The fighting open order line fed from the rear requires more steadiness and more discipline. Surely this ought to be no objection to Englishmen.

2. Artillery may hold its place against infantry, provided it have reason to expect succour in a short time and be not altogether unprovided with escort. Small broken bodies of infantry may indeed slip on unperceived, but can effect little against the great batteries which ought to be accumulated.

Infantry can kill men but cannot kill guns. Even one or two gunners left with a gun can work it, and have done so, in our service again and again. The fire of artillery has much more power of demoralizing the enemy than would appear from the number of men who fell killed or wounded under its effects.

When a number of guns support each other they give a flank as well front fire on every spot in front of them.

A cavalry escort will check infantry by merely showing itself when in combination with guns.

Limbers can generally be sheltered, or at the worst, if the horses face towards the rear, the limbers will act to great extent as shields for the animals from infantry fire. Why should not bullet-proof shutters be carried with the limbers to protect the horses?

3. There can be no place absolutely right in all cases for artillery on the march. Generally its most useful place will be in advance of all except the advanced guard and still more advanced cavalry. Sometimes, as in woods and defiles, when the enemy is at hand, it would be dangerous and useless to have the artillery in front. But those who, as a rule, fear for the guns if in advance, have hardly appreciated the value of the protecting cavalry veil which should always, when possible, float before the head of the columns.

4. Roads are now so many and so good, that artillery is easily moved in all civilized countries. Long range renders change of position less frequently necessary, therefore artillery horses are less constantly overworked in war, and may be kept in perfect condition. The use of heavier field guns is for these reasons quite practicable; but long range with powerful projectiles is useless without range-finders, which have not yet received the attention they deserve in this or any other country.

5. It was proved again and again in the late war that gray horses attract the attention of an enemy more than those of any other colour. Gray batteries invariably suffered much more than the others.

6. The old dispute between massing guns or concentrating the fire of separated batteries is held by all who have seen war on a modern scale as unpractical. So many guns are brought into action at once, sometimes before the infantry are engaged at all, that the only difficulty is how to find positions enough for them, whence a good view of the enemy can be obtained.—C. B. B.

Captain BRACKENBURY: Or rather that I think they are not fit for any position in which they may be placed. I am the son of an officer who fought as a subaltern in the Peninsula and was wounded as a subaltern at Talavera and Salamanca. I am myself only a captain, and not yet very old, so that I should certainly be fouling my own nest if I were to speak disparagingly of the younger Officers of the British Army. What I do say is this, and I hear it on every side, and I have heard it from the younger Officers of your Royal Highness's battalion, that they know that they have not got the fighting training they require. They do not learn for example how to attack an enemy in a wood, how to move to the attack on different natures of ground, and they crave and beseech to be taught.

Lord DE ROS: That is the ignorance which I denied.

Captain BRACKENBURY: I assure his Lordship that they admit it themselves. As to the question of firing over the head of infantry, if it were possible to avoid it, it would be most desirable to do so. There is always the risk of premature explosion, but when the whole front of the position becomes covered with infantry, there are only two choices open; one is, that the artillery advance in front of the infantry, which I think scarcely any one would desire, or else it must fire over the heads of its own troops, unless it ceases firing altogether. Sir Lintorn Simmons has fully answered the question put by Sir Wm. Codrington as to the system of attack which I advocate, and the system used by the Prussian army up to this time. The difference is simply this. The final rush, I perfectly admit, is, in either case, made by a line of troops, but the whole point is the way in which, in the first place, the troops are brought up to deliver the necessary fire which must demoralise the enemy before that rush can by any possibility be made. In the one case, the attempt is made to move up a battalion or a half battalion in line, as laid down in our new order; where it is said that the reserve half battalion, if there is a chance of advancing against the enemy, is to deploy into line, and to advance and pass through the skirmishers to attack a position which will even then be 300 yards off. They must thus advance in a line of half battalion over 1,000 yards. In the other case the shooting, fighting, skirmishing line, is fed by small bodies brought up in succession in extended order, and then there is only left the last 300 yards' rush for the reinforced flexible line, a line to all intents and purposes, when the last grand attack has to be made, and I believe that this advance can now only reap the fruits of the fire and cannot itself be the chief demoralizing element.

The CHAIRMAN: I am sure I am expressing the opinions of all here present in thanking Captain Brackenbury most sincerely for his able and excellent lecture on this very important subject,—a subject which, at this time of changes in drill and tactics, cannot fail to be of the deepest interest to soldiers of every branch of the Service. My friend, Captain Brackenbury, has had great opportunities of practically judging for himself the working of the different arms in the field, and we thank him most sincerely for having brought forward this subject in such an instructive manner.

Evening Meeting.

Monday, May 19th, 1873.

REAR-ADMIRAL SIR ASTLEY COOPER KEY, K.C.B., President, Royal Naval College, Greenwich, in the Chair.

NAMES of MEMBERS who joined the Institution between the 15th and 19th May, 1873.

LIFE.

Brown, J. Clifton, Capt. Royal Lanc. Art. Mil.

ANNUAL.

Clarke, T. C., Captain R.E.
Loch, H. B., C.B., Lt.-Col., 2nd Cheshire Mil., and Lieut. Gov., Isle of Man.
Voyle, J. R. C., Lieutenant Bengal Staff Corps.

RIFLING FOR HEAVY GUNS.

By Captain J. P. MORGAN, R.A., Assistant Superintendent Royal Gunpowder Factories.

THE principles of rotation are very recondite, and have been the subject of some abstruse investigation; but it is not necessary to consider them mathematically, in order to understand their application to the rifling of guns.

They may be briefly stated as follows:—

In every rigid body there are "three principal axes," about which the body is capable of rotating permanently.

Two of these, the greatest and the least, are "stable axes of rotation," *i.e.*, if the body rotate round an axis having a very small inclination to either of these axes, it will continue to rotate without further divergence. The medium principal axis is an "unstable" axis of rotation, *i.e.*, if the body rotate round that axis exactly, it will continue to do so; but, if the axis of rotation be inclined to it in the very least, the inclination will become greater and greater. With these exceptions, the body will not rotate permanently round any axis, but, in all cases, the axis will change its position in the body until, at last, the rotation is round its shortest axis, which is the most stable of all.

When a body rotates round a stable axis, and is not acted upon by impressed forces, the axis of rotation not only retains its position in the body, but also in space, by always remaining parallel to itself. If, therefore, there was no resistance of the air to an elongated projectile after leaving a gun, the question would be very simple, for, all that would be necessary would be to give a comparatively feeble rotation round the longest axis, and the shot, by virtue of the rotation imparted, would go nearly point foremost for a considerable part of its trajectory. It would not, however, be possible to make the projectile strike point foremost at very long ranges *in vacuo*, and when we find, therefore, in practice, that it is possible to make rifled projectiles strike point foremost, even at very long ranges, we infer that this is due to the resistance of the air, and are led, not only to consider the causes which

produce this result, but *the simplest* method of obtaining it. It cannot be due, as some suppose, to the tendency of the projectile to take that position which gives least resistance, for then there would be no necessity to give any rifling at all. The laws which regulate the action of impressed forces on a rotating body have been pretty well determined, and, though they do not, owing to the difficulty of determining the resultant action of the resistance of the air, enable us to solve this question theoretically, they give great aid in drawing correct conclusions from observations derived from experiment. Whatever be the action of the resistance of the air, we know that it can be represented by two forces, one of which acts through the centre of gravity of the projectile and tends to produce a change in its velocity and direction, while the other tends to produce rotation round some axis, and thus tends to produce a change either in the direction of the axis or in the velocity of rotation, or both.

I shall consider more particularly the latter of these two forces.

It is a law in mechanics that, if a rotating body, whose axis and velocity of rotation are represented in direction and amount, by a straight line, be acted on by forces which would produce another rotation whose axis and velocity may be similarly represented by another straight line, the result is a rotation whose axis and velocity may be similarly represented by a straight line forming the diagonal of the parallelogram of which the two straight lines are the sides. All these lines pass through the centre of gravity of the body. If the axis of rotation be a stable axis, and the forces be gradually applied, the axis does not change its position in the body, but only in space, and the amount of change is proportional to the amount of force applied, compared with the force which would produce the original rotation.

This law may be illustrated by the gyroscope. If the gyroscope receive a rotation which to the spectator is seen to be in the direction of the hands of a clock, it may be represented by a straight line drawn in the direction of the axis towards the spectator. If now a weight be hung at the extremity of the axis towards the spectator, this tends to produce a rotation which may be represented by a straight line drawn from the gyroscope to the left, the result is, that the axis takes up a new position between the two, and moves to the left. If the weight be hung at the extremity of the axis from the spectator, the tendency to produce rotation will be represented by a line drawn to the right, and the axis will move to the right. So long as the weight is suspended, the deflection continues, and it ceases when the weight is removed. It will be observed that, when the rotation is considerable and the weight not too heavy, the deflection is almost exactly to the right or left; but, if the rotation be low or the weight considerable, there is also a tendency of the point of suspension to drop, so that, at each gyration, it descends lower and lower. I desire that this fact may be particularly borne in mind, as it explains why it is necessary to give a considerable rotation to rifled projectiles.

Another illustration may be given by the spinning of a top. The axis round which rotation is given is a principal axis, and thus there is no tendency to change its position in the top. If, when the point comes

down on the ground, the axis is vertical, the top will at once spin steadily on the ground. Usually, however, the axis is inclined to the horizontal, and the weight of the top, acting through its centre of gravity, tends to produce a rotation round an axis perpendicular to the axis of the top. The position of the axis thus changes; and at first the point describes large circles, rolling on the ground, the axis always being inclined inwards. When the point has become fixed in one place, the top describes complete gyrations. A peculiar motion is then observed, for the gyrations become smaller and smaller, until the top spins on a vertical axis or "sleeps" as it is called. This is due to the friction of the point on the ground, which a little consideration will show ought to produce this effect. As, however, the rotation becomes slower, the top begins again to gyrate, and, in spite of the friction on the ground, the gyrations become larger and larger, until the point begins to describe small circles on the ground, and the top wabbles. This last sort of motion very well represents the motion of a free rigid body rotating under the influence of impressed forces of comparable magnitude, and, as we shall see, has to be considered in the case of rifled projectiles as they move through the air.

The motion of the earth, which produces what is called the precession of the equinoxes, is another illustration of the same sort of motion. The shape of the earth is that of an oblate spheroid, and may be considered as a sphere enclosed in a hollow shell, which is thickest at the equator and tapers off towards the poles. The attraction of the sun on the sphere has no tendency to produce rotation; but, on the shell, the attraction of the sun is greater on the half nearer than on the half more remote. The resultant action is a tendency to draw the equator into the plane of the ecliptic, and produce a rotation round an axis perpendicular to that round which the earth rotates. The consequence is that the earth describes a huge gyration, once in about 25,000 years, similar to the top in its final stages, but in the opposite direction. For it will be observed that, whereas the weight of the top tends to increase the angle at the apex of the cone of gyration, the attraction of the sun on the earth tends to diminish it. And I should expect to find, also, if observations could be made for the gigantic period that would be necessary, that the obliquity of the ecliptic is gradually becoming less and less. It appears to me that to this cause is probably due the glacial periods which seem to have covered the whole surface of the globe, for, if the obliquity be becoming less, it must at one time have been greater than it now is; and, if the obliquity at one time has been very great, it would be sufficient to account for extreme heat and cold, every year, all over the globe. There is another action which, like the friction of the peg of the top, tends to retard the rotation of the earth, viz.: the friction of the tides, which Myer, in an elaborate calculation, has endeavoured to show is at present compensated for by the contraction of the bulk of the globe. The ultimate result must be, if sufficient time be allowed, that the earth will present only one side to the sun, a condition which we find in the case of the moon with regard to the earth, and, which Mr. Rigg has suggested to me, has been brought about by a similar cause. Doubtless, also, the fluid interior of the globe will

exercise a disturbing influence, and, considering that the laws which govern a fluid body in rotation under the influence of impressed forces differ in the results produced by them in the case of a rigid body, it has often occurred to me that the axes of rotation of the two are not coincident, but that there is a friction between the two surfaces which produces the magnetism of the earth, and also may be the cause of the periodic risings and subsidences of the crust of the globe so well known to geology, because thus the two equators would be continually altering their positions with regard to each other. The effect of the laws of rotation on the solid and fluid portions of the globe is an interesting speculation, but I should not care to carry it into the dark future, seeing that we are met with the prediction that our earth is not destined to last for ever. The three laws—heat, elasticity, and attraction of gravitation—were given to matter in the first three days of creation. The law of heat appears to be the only one which is fading away, but the promise is, "yet once again I shake the heavens and the earth," which not only appears to establish the undulatory theory of heat, but also may explain the other statement that the elements shall melt with fervent heat, or be dissipated by intense incandescence into space, possibly again, under the influence of these same laws, to form new worlds, in the way La Place has shown the universe to have been made.

Seeing therefore that the laws of rotation exist, not only in theory, but in undoubted fact, no explanation of the motion of a rifled projectile can be considered satisfactory which leaves them out of account.

If the shot come out of the gun perfectly centred, *i.e.*, rotating round its longest axis, and having that axis coincident with the line of flight, there will be no tendency either of the axis of rotation or of the projectile itself to deflect, so long as the motion is in a straight line, because the resistance of the air will act uniformly all round. As soon, however, as the trajectory has begun to curve downwards under the influence of gravity, the resistance of the air acts more on the under side than on the upper, and effects will be produced depending on the resultant direction of the resistance of the air in relation to the centre of gravity. If, as in the case of service projectiles, the resultant action be through a point of the axis in front of the centre of gravity, the shot will commence to gyrate in the same direction as a top; and, the resistance of the air, acting on the exposed side of the projectile, will cause it to be carried bodily from the trajectory in the direction of the deflection of the point; but, if the resultant act through a point behind the centre of gravity, as is supposed to be the case with cylindrical shot,* the gyration will be in the same direction as that of the earth, with a corresponding deflection of the shot. In both cases the tendency is to gyrate round the trajectory.

The rate of the gyration will depend on two things, viz.:—the amount of original rotation given to the shot, and the amount of force tending to produce a second rotation round an axis perpendicular to the first. If the amount of orginal rotation be low, the shot will begin to gyrate with a smaller deflection of axis than if the rotation be great. A low rotation,

* Proceedings O.S.C., 9th May, 1864, Minutes 11,804 and 11,805.

therefore, is to be preferred to a high rotation, as keeping the point closer to the trajectory. There are some causes, however, which interfere with the possibility of giving a very low rotation. In the case of the top, we have seen that, when the rotation is low, the gyrations become larger and larger. The same is to be observed in firing rifled service shot with too low rotations. They seem to go steadily at first, but afterwards begin to wabble as they proceed. In the case of the top, we saw that the friction of the peg on the ground tended to diminish the size of the gyrations, but, in the case both of cylindrical* and service shot, the friction of the air tends to increase their size, for, according to the principles investigated by Robins and Magnus, the rotating surface carries with it a current of air which meets the resistance of the air in different directions, and, the side of the head which leads the gyration and is rotating inwards, meets a greater resistance than the opposite side which is rotating outwards. In order, therefore, that the gyrations may not become too large before the end of the trajectory is reached, a sufficient amount of rotation must be given. The exact amount required is a matter well worthy of consideration, and varies in different guns, not only according to the length and diameter of the projectile, but also according to the amount of "centring" the shot has when it leaves the gun. With equal masses, the relative stabilities of shot varying in length, may be expressed inversely as the twist in calibres, but the longer projectile allows the resistance of the air to act with a greater leverage,† and increased rotation must be given to compensate for this. After the necessary allowance has been made for this, the main cause which prevents a very low rotation being given is, that a shot rarely ever leaves the gun exactly centred. If the shot come out not centred, but having an initial deflection of the axis, it at once commences to gyrate, and that too at the time when the resistance of the air is the greatest, so that when a properly centred projectile may be only at its first gyration, a projectile not properly centred may have reached its second or third, and that too under the adverse circumstances of increased resistance of the air which the other would have escaped. In order, therefore, to prevent the large gyrations being attained too soon, an increased rotation has to be given.

As an illustration of the effects of want of centring, I would offer the bad shooting of the original Lancaster gun. The outrageous

* Proceedings O.S.C., 19th September, 1862, Minute 7,381; and 8th May, 1863, Minute 9,015. The greater unsteadiness of cylindrical shot compared with service shot is probably caused by the fact that the flat head causes greater resistance of the air, and the friction acts at a greater leverage. This is not inconsistent with the supposition that cylindrical flat-headed shot deflect to the left, because, though the resultant action of the resistance of the air might act behind the centre of gravity, the action of the friction would probably still be felt most at the head, where the air was most, though uniformly, condensed all round. The true deflection of flat-headed projectiles cannot as yet be said to be satisfactorily determined.

† This greater leverage is, however, compensated by the smaller surface of the head which is exposed to the resistance of the air. It is probable, however, that the leverage increases more rapidly than the length of the shot. With the Snider bullet the resultant action of the resistance of the air must have acted very nearly through the centre of gravity, else the very low spin would not have been sufficient to insure the very tolerable accuracy of fire which has been obtained from it.

system of rifling, together with the badly fitting projectile which was adopted in this gun originally, made it an impossibility for the shot to come out properly centred. The consequence was that the practice made by it was very erratic, even with very high velocities, and the very considerable rotation which was given. The path of the projectile could be traced by the eye as it described a sort of spiral, sinuous, or corkscrew motion, at one time deflecting to the right and then to the left, and so on. Very much better shooting has been obtained from guns with one-third of the twist, and there can be no doubt that the reason is to be found in the fact that they delivered their projectiles better centred.

It is a curious fact that, with our service projectiles, the deflection is always to the right, and to this, no doubt, is due the accuracy of fire which is obtained by them; for, if at one time they should deflect to the right and at another to the left, it is scarcely possible to make accurate practice. A very crude theory, which I am sorry to say has found very considerable acceptance, has arisen from this fact. It is that "a shot "rotating rapidly and at the same time falling in the air, will expe- "rience a greater pressure underneath than above, and will, therefore, "roll, as it were, on the denser air below." That this cannot be the case is at once evident, when we remember that, according to the principles determined by Robins and Magnus in the case of round shot, it ought to produce a deflection in exactly the opposite direction, and, if it were the true reason, our service rifled shot ought to deflect to the left instead of to the right.

Professor Bashforth offers a better explanation in his valuable book on the "Motion of Projectiles," recently published. He says, p. 65, "The shot will have a sinuous motion. But as the *first* deflection of "an ogival-headed shot spinning with right-handed rotation is to the "right, and afterwards, as its point is directed more to the right than "to the left, the shot will have a deviation on the whole greater to the "right than to the left."

I have plotted some very accurate practice made with a B.L. 40-pounder Armstrong gun,* which is perhaps the most accurate shooting gun we have ever had in the service. This I did with the view of finding how the deflections varied. I found there was little or no deflection up to 700 or 800 yards. Then the deflection began to be appreciable, and increased up to about 1,200 yards, when the rate of deflection appeared to attain a maximum. After that, the rate of deflection to the right decreased, and I carefully watched to see if I could find any deflection in the opposite direction to the left, but I could trace none. From about 1,500 to 2,000 yards or more, there appeared to be very little tendency to deflect at all, but beyond that, the deflection to the right began to manifest itself, and at about 2,500 yards range it had again attained a maximum to the right, gradually after that diminishing, and, at more than 3,000 yards, showing some symptoms of deflection to the left.

It appears to me that the following diagram would very well repre-

* Proceedings O.S.C., 22nd October, 1862, Minute 7,634.

sent the deflection of the point in this instance, both in accordance with the facts observed and with the laws of rotation I have noticed.

The concentric circles represent the base of the shot, and the dark spiral line the supposed deflection of the point. The eye is supposed to be looking always in a line tangential to the trajectory. The dotted line is the course the point would take were the trajectory to be prolonged beyond the usual ranges, or which it would take were the shot

not properly centred. The reason of this somewhat curious, but very valuable, motion of the point appears to be due to the fact, that the dip of the trajectory materially interferes with the tendency to gyrate. As the point is gyrating downward the trajectory is also curving downwards, and it is the comparative rates of these two motions that produce the effects observed. At first the point will be dipping more rapidly than the trajectory, but, as the resistance of the air diminishes and the point comes closer to the trajectory, by virtue of the forward motion of the shot in the direction of the axis and the inward motion of the point due to the resistance of the air acting above the head, the dip will be less, and so the point does not get round below the trajectory at all. It will be observed that the first gyration is small, and, if we suppose it to occupy the time the shot would take to range 2,200 yards, the effect will be that the axis of the shot will coincide pretty closely with the trajectory for that distance. The second gyration is shown larger, because the resistance of the air has then become less, and the gyration will be made under a greater exposure of surface. This second gyration is therefore what we should have as the first gyration if we were to increase the spin, for the greater stability the shot would have, would cause it to wait until a greater amount of surface had been exposed before it would gyrate. It is important to notice this, because greater spin thus involves greater deflection of axis, and, consequently, greater resistance of the air; and that this

reasoning is sound is proved by the fact, that guns with a rapid twist, if they are accurate shooting guns, and do not deflect at one time to the right and at another to the left, as did the Lancaster gun, always deflect more to the right than those with a less twist.*

I have dwelt at some length on these principles because it is necessary to know exactly what we have got to do in rifling guns. It is a mistake to suppose that giving a very great twist is all that is required. What is required is to limit the extent of the gyrations as much as possible, so as to keep the point as close as may be to the trajectory, and thus insure less resistance of the air during the whole flight of the projectile and the greatest penetration at any point, and what is of still greater importance, to insure that the gyrations, whatever they may be, shall be regular, so that they may be allowed for and give accurate shooting. This last can only, it appears to me, be insured by proper centring; for if the projectile be not properly centred, there is always an initial cause to interfere with the after regularity of the deflection. There can be no doubt, however, that a rapid twist is the best thing that will compensate for want of centring, because, in the first place, it is not so easy to deflect the point of the shot as it comes out of the gun, when the twist is great; and, in the second place, any initial deflection which may exist becomes more readily absorbed in the larger and more stable gyration which afterwards ensues. It is better, however, to do with a less rapid twist and more perfect centring, not only because it strains the gun and the projectile less, but also because it in reality insures more accurate shooting.

No one will doubt the fact that some rifled guns shoot better than others, though some may be disposed to question whether the better shooting is due to more perfect centring. I may state therefore, in further support of the view here advocated, the results obtained in some experiments made with the Bashforth chronograph to determine the resistance of the air. This instrument gave a very accurate measurement of the resistance of the air, both with round shot and rifled projectiles. With rifled projectiles, the resistances were found to vary to a much greater extent than with round shot, and it is reasonable to suppose that where the resistance of the air was least, the projectiles were best centred, and less perfectly centred, when the resistance of the

* The following table, taken from "Reports of Experiments with the Bashforth Chronograph," shows the co-efficients of the resistance of the air with Whitworth and Service projectiles, page 168:—

Velocity.	Whitworth Flat-headed shot.	Ogival Radius = 1½ diameter.	Hemispherical head.	Spherical shot.
f. s.				
1140	·0001396	·0001079	·0001329	·0001534
1060	·0001246	·0000972	——	·0001473
928	·0001384	·0000659	——	·0001385

This shows that, with Whitworth shot, the co-efficient of resistance does not decrease with the velocity of translation in the same manner as Service rifled and spherical shot. I have no doubt that the greater spin with Whitworth shot is the cause of this, as explained in the text.

air was greatest. Great differences were sometimes found in this respect, and it was a rule that when the resistance of the air was great, the accuracy was not so good, and *vice versâ*. One gun, a long B.L. 40 pr., converted into a M.L. 47-pr., was remarkable both for the small amount of resistance it gave and for its great accuracy of fire. No difficulty was found in firing through 10 screens with it without mishap, and it could be fired with accuracy at lower velocities than any of the other guns. The regularity of the resistance of the air was also very remarkable as compared with the other guns.

If the shot came out of the gun without any deflection of the axis, but rotating round an axis inclined to the longest axis, it would be sufficient to account for the increased resistance of the air. For many reasons I am not disposed to think that this is ever the case. It would not account for the generally inferior shooting which was found with increased resistance, and I cannot see how the small amount of play the projectile has in the bore of the gun, would be sufficient to allow for the great differences in resistance which were found to exist, sometimes as much as 25 or 30 per cent., or even more.

The question arises, how can we suppose a sufficient amount of initial deflection to account for so great an amount of increased resistance, but it will be admitted that there are various causes which will account for this. If the shot be knocking itself against the bore as it moves on, it may have a final knock as it leaves the gun which will have the effect of deflecting the axis sufficiently to account for the differences observed.

It is possible that such a knock might be sufficient to upset the stability of the axis, and cause rotation round an axis inclined to the longest, and I am aware that some people hold this view, and think that it accounts for a very curious fact which has been observed in the penetration of iron plates. On this supposition the shot comes out of the gun rotating round an axis inclined to the longest axis, and thus at short ranges the amount of surface presented is greater than at longer ranges, when the shot, by virtue of the stability of its axis, has had time to centre itself.* I would offer a suggestion however which, it appears to me, would account for this fact without supposing that the stability of the axis is upset. It is this. At the moment the shot is leaving the gun, we may suppose that it is rubbing along the bottom of the bore, and that the gas is rushing over the base of the shot. As soon as the lower part of the base is unsupported, the effect of the gas pressing downwards will be sufficient to give a considerable initial deflection of the point to the right. At first, therefore, the point of the shot will not be in the best position for penetration, but, as it proceeds, the point will dip and will not only conform more to the trajectory but also to the face of the target, which generally has a slight inclination backwards. It seems to me that this action of the

* General Mayevski supposes another sort of centring action different from this, and probably the same as that given in the text where the curve of the trajectory interferes with the gyration, and at one point brings about a close coincidence between the axis of the projectile and the trajectory. This is not, however, what is here referred to.

gas would not be sufficient to upset the stability of the axis, because it is familiar to everyone, from the noise that a rifled shot makes on ricocheting, that the stability of the axis is not upset, but only that the point is very much deflected, which causes the regular roaring noise which is heard, each gyration being distinctly traced by the ear. Now, if the severe blow on striking the ground, which causes so great a deflection of the point is not sufficient to upset the stability of the axis, I do not see how the lesser blow of the gas on the base of the shot, which produces a much smaller deflection, will be sufficient to do so.

This view is strictly in accordance with the fact that the best remedy for want of centring, is to be found in a long gun. All our longest rifled guns shoot best, and, if what I have stated be correct, it is to be expected that they should do so, for the longer the gun, the less will be the stress of the gas as the shot leaves the muzzle, and the less will be the knocking, if any, against the sides.

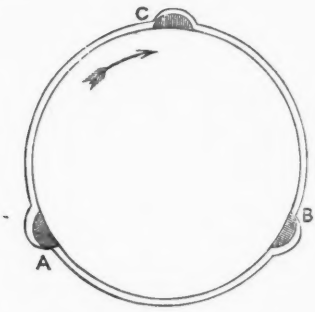
It was found in the Bashforth experiments, that the 9-inch gun gave less resistance of the air when fired with 36 lbs. of R.L.G., than with 43 lbs. This appears to support the idea. Practically, it was found that, though 43 lbs. gave 40 feet more velocity than 36 lbs., yet the latter charge would have a greater striking effect at 2,000 yards.

Too much attention has, I think, been given to centring in the bore of the gun itself. What is wanted, is that the projectile shall be centred as it leaves the gun. It may be centred all along the bore of the gun, but, if it receives a blow from the gas as it leaves the gun, all the advantage will be thrown away. If by centring in the bore, any knocking against the sides can be mitigated, this will undoubtedly be an advantage. We ought, however, to take a lesson from the results of experience, and I think it will generally be admitted, that a long gun is the best method of insuring accurate centring and consequently accurate shooting.

A great many methods have been tried, with the view of securing accurate centring. The first and perhaps the best, was Sir William Armstrong's system of lead-coating. The shot was kept jammed in the bore through its whole length and could not possibly wabble about. His shunt gun also provided for centring as the shot left the muzzle, by shallowing the grooves just before the shot effected its passage out of the bore. Sir Joseph Whitworth tries to get centring by making his shot as near as possible a mechanical fit, with a considerable amount of success. I have no doubt, however, that his taper base has something to do with the accuracy of shooting he has attained, for it will allow the gas to act more uniformly round the base of the shot as it leaves the gun. This taper base, however, involves a semi-flat head, so as to avoid too great deflection; but the greater resistance of the air which accompanies this is objectionable, and should be avoided if possible.

Another method, which has found many advocates, consists in making the shot centre itself. The principle, on which this depends, was first explained to me by the late Major Haig, R.A., one of the most scientific Officers the Royal Artillery has had in recent times, but I am sorry to say has now lost.

It is as follows:—



Suppose a shot, moving along the bore of the gun, is compelled to rotate as shown by the arrow by the bearings at the points A, B, and C, then, by virtue of its inertia, it will assume a position where the rotation is least; and this can only be in the centre of the bore, for, it will be observed, that, if it goes to one side, the bottom for instance, it can only do so by taking more rotation, pivoting round the point A. Rather than do this, it will centre itself in the bore of the gun. Captain Scott, R.N., claims this as an advantage, with his system of rifling, which consists of long iron ribs on the shot, giving a sufficient amount of bearing surface to prevent any wear of the ribs, which would of course, interfere with the perfect action of this principle.

The Woolwich system is well known, and practically consists in giving rotation by a single row of soft studs all round the projectile, so as to allow of an increasing twist being given to the grooves of the gun, and thus reduce the maximum strain caused in giving rotation, both on the studs and gun. The small amount of windage given between the shot and the bore, is considered sufficient to give accurate centring. The windage over the studs also, is less than over the body of the projectile, so that the soft metal studs receive any side blow which may be given to the bore of the gun, and thus diminish any knocking action that may exist.

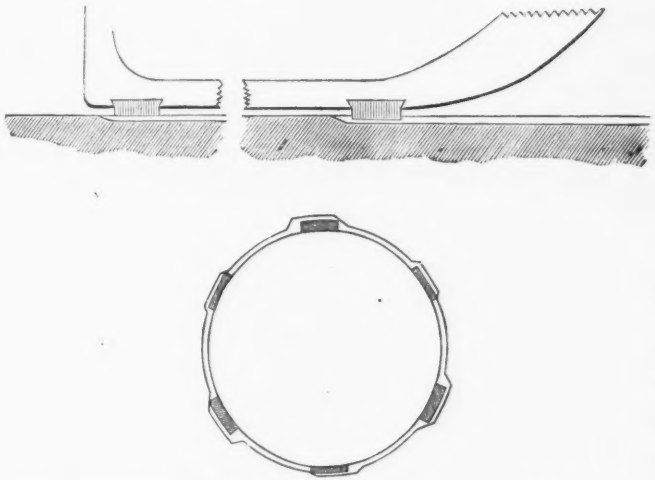
These are all the systems which have been tried in this country, which have given results entitling them to be considered applicable to heavy guns; but there are two others I may mention, which have been adopted or tried by foreign Governments, which I think worthy of consideration.

The Austrian Government tried a very long B.L. Gun, which fired lead-coated projectiles, but which differed from the Armstrong, not only in the breech-loading action, but also in the grooving of the gun. The number of grooves was reduced to one-half, and the grooves were made very wide, while the lands were very narrow, so that, practically, the lands cut readily into the lead-coating, and thus diminished the friction, while the power to produce rotation was not reduced, but

rather increased, for, it will be admitted that, as the lead-coating is much softer than the steel land which cuts into it, the strength of the lead-coating will be increased in this manner, while the steel land will have sufficient strength.

The other system I wish to mention is that adopted by the Norwegian Government. It has an uniform twist and has one row of studs all round the projectile towards the front, to produce rotation, and another towards the base to give centring. These two sets of studs have separate grooves.* The driving grooves are deep, but terminate at some distance from the powder-chamber. The steadying grooves are shallow, and are carried up to the powder-chamber. The studs are not rounded off but are purposely left angular, so that, by the first wear of the driving studs, the projectile may come gradually into bearing, and also allow the steadying studs to leave their grooves and jam themselves tightly in the bore of the gun.†

The following wood-cut shows the grooves and studs with their 3-pounder mountain steel gun :—



A great many points of considerable importance must be borne in mind, in considering the value of these different systems of rifling.

* In the smaller guns only. In the larger guns the driving and steadying studs are in the same groove, and a similar action is obtained by sloping away the driving edges of the driving-studs.

† I am persuaded that some sort of action as this exists in the Woolwich gun, for it will be observed in the recovered projectiles that, in some cases, nearly one-half of the studs are worn away. Thus one half of each stud may give rotation, and the other half centring.

The first, and not the least, is the effects they have on the strength of the gun. Those which cut deep grooves are most detrimental in this respect, and thus far the Austrian experimental gun has an undoubted superiority, for, not only are the grooves shallow, but, what is of much more importance, they are many and broad. One groove in the bore of a gun injures the gun much more than fifty; for, we must not only provide for the strength, but also for the stretch of the bore. If there be only one groove, the whole stretch tends to come on that part, because it is weakest and yields most readily. It is the same principle, which has been successfully avoided by Sir William Palliser, in making the body of his bolts less in diameter than the weakest parts of the thread, so that the stretch comes on the body which is long rather than on the shallow part of the threads, which are comparatively very short. The defect of this law was also discovered and early avoided in the Royal Gun Factories, by not cutting the thread for the breech-screw deeper into the breech-piece than that part which received the steel tube. No other system avoids this objection, for we find they all cut grooves into the bore of the gun and thus injure it more or less. Even Whitworth's hexagonal system of rifling is a grooved system in this respect.

Those systems which have most grooves are, however, to be preferred to those which have fewer, and the fact that the Norwegian system has a double number of grooves is rather an advantage than a disadvantage, and so I have heard it claimed by an intelligent Officer of that country.

In connection with the effect any system of rifling has on the strength of the gun, a most material point is the windage given. From my experience of the nature of powder hitherto manufactured for heavy guns, I consider it very advisable that some windage should be allowed to act as a safety valve after a certain point. A very small increase of the amount of powder consumed, causes a very great increment of pressure; and a very small amount of windage gives a corresponding relief. This is a very difficult problem, for windage is also the main cause of the scoring and destruction of the guns at present in the service. The only escape out of the two objections, that I can see, is to stop the windage over the body and give it through the interior of the projectile, utilizing it at the same time to ignite the fuze. Lead-coating effectually stops windage, advantageously or disadvantageously, and in this respect is superior or inferior to all the others, according to the circumstances of the case. I believe, however, it is possible to stop windage in all guns by the use of an expanding wad, which would thus render them all practically equal in this respect.

It remains now to consider the strain and friction on the surface of the projectile, and on the grooves of the gun. The easiest way of doing this is to compare the amount of force required to produce rotation with that to produce translation, and also the friction of the shot along the bore.

Let x = the distance travelled by the shot in the time t.
θ = the angle of rotation described in the same time.
P = pressure producing translation.
p = do. do. rotation.

Then in a cylinder of r = radius, and M = mass, for one turn in n calibres.

$$x = nr\frac{\theta}{\pi}$$

$$\frac{d^2x}{dt^2} = \frac{nr}{\pi}\frac{d^2\theta}{dt^2}$$

$$\text{but } \frac{d^2\theta}{dt^2} = \frac{pr}{M\frac{r^2}{2}} = \frac{2p}{Mr}$$

$$\text{and } \frac{d^2x}{dt^2} = \frac{P}{M}$$

$$\therefore \frac{P}{M} = \frac{nr}{\pi} \times \frac{2p}{Mr}$$

$$\text{and } P = \frac{2np}{\pi}$$

$$= 25p \text{ if } n = 40.$$

Thus, with an uniform twist of 1 turn in 40 calibres, the force producing rotation at the surface of the shot is 4 per cent. of the total pressure of the gas at any moment on the base of the shot. The useful effect of the force of translation absorbed is, however, the resolved part of this along the bore, or about $\frac{1}{15}$ of 4 per cent.—*i.e.*, $\frac{1}{3}$ per cent. nearly. The friction, however, has to be added to this, which, supposing it to be $\frac{1}{4}$ of the pressure, gives 1 per cent. in addition, thus using altogether $1\frac{1}{3}$ per cent. of the force of translation. Thus with a 600-lbs. shot in a 12-inch bore, with 20 tons per square inch of maximum pressure of powder, the pressure producing rotation would be 90 tons; with a 15-inch gun and 1,200-lbs. shot and 25 tons pressure it would be 180 tons. If we suppose excessive pressures, as often occur in the bores, of twice or thrice the amount supposed, these pressures will be doubled or trebled.

The effect of the increasing twist is to make the amount of pressure depend, not on the amount of maximum pressure of the powder, but on the amount of rotation to be produced, distributing the pressure more uniformly along the whole bore of the gun, and making it less as the length of the gun is increased. With the length in use with our service guns, and with the twist used in the 10-inch gun, from 1 turn in 100 to 1 in 40 calibres, it has been shown by Captain Noble,* late R.A., now of Elswick, that the pressure is uniformly distributed, with the pressures found by the Committee of Explosives to exist in that gun, and does not exceed $\frac{1}{2}$ of what it would be if the twist were uniform. If, however, the initial pressure in the bore were doubled or trebled, there would also be a maximum pressure double or treble the amount calculated.† The twist

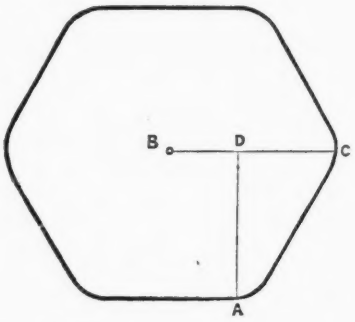
* "On the pressure required to give rotation to Rifled Projectiles," by Captain Noble, F.R.S., &c., late Royal Artillery. *Philosophical Magazine* for March, 1873.

† Captain Noble takes no account of these very high pressures in his calculation. They ought not, however to be omitted in the consideration of the proper rifling of

increasing from 0 to 1 in 40 would have the effect of giving a greater pressure towards the muzzle of the gun than one from 1 in 100 to 1 in 40, but it would have the advantage of having no maximum pressure at the commencement of motion, when the initial pressure on the base of the shot was doubled or trebled. The practical result, therefore, of an increasing spiral is that, with a good uniform powder, it is about $\frac{2}{3}$ that of an uniform twist, but with a maximum pressure of twice or thrice the legitimate pressure in the powder-chamber, it will reduce it to $\frac{1}{3}$ or $\frac{2}{9}$ of what an uniform twist would give under similar circumstances.

In order, therefore, to provide against all possible contingencies, an uniform twist ought to have 4 times the strength of studs or ribs to be as safe as one increasing from 0 to the same amount of twist with guns of the service length. If, therefore, an uniform twist has 4 times the bearing surface as an increasing twist, it is practically as safe. Comparing, therefore, Captain Scott's system with the Woolwich on this subject, I am compelled to admit that it is quite as safe, and, indeed, very much safer, for it has much more than 4 times the bearing surface.

The shunt system has nearly, perhaps not quite, 4 times the bearing surface, and, I doubt not, would be quite strong enough. The Whitworth gun has much more than 4 times the bearing surface. The pressure which produces rotation, however, by no means acts at the extremity of the radius of the projectile, but at between $\frac{1}{2}$ and $\frac{1}{3}$ that distance, as will be observed by the accompanying woodcut, where the pressure at A, the driving edge of the groove, acting normally to the surfaces, has a direction, A D, which practically makes B D less than one-half the radius, B C.



our heaviest guns, in which they are found to a very great extent. It is because they exist that the increasing twist from 0 to 1 in 40 is superior to one from 1 in 100 to 1 in 40; and I have no doubt that it is for this reason that the latter twist has been abandoned in favour of the former. The 10-inch gun has a twist from 1 in 100 to 1 in 40, and it will be observed that projectiles fired from this gun have the studs very much worn. It is worthy of remark, that both the 10-inch and 35-ton guns shoot remarkably well; the latter gun has a twist commencing from 0.

Taking a 600-pounder gun and high pressures, we should, under the same conditions as before, have about 700 tons producing rotation, which would be more than 100 tons on each edge; and, if we suppose the driving edge to be 1 inch wide* and 20 inches long, it would, with 1 turn in 40 calibres, give a pressure of 5 tons per square inch, which, on the great amount of surface employed, must produce enormous friction. With a 1,200-pounder it would be worse and worse; about 8 tons per square inch on a still greater surface. Still worse, however, Whitworth's small bore necessitates a twist of 1 turn in 20 calibres, so that these pressures, great as they are, would have to be doubled. It is difficult to estimate the amount of longitudinal pressure that would thus be consumed, the co-efficient of friction with such high pressures being very great: probably it would not be less than 10 per cent.

Captain Scott's system, having less bearing surface, but acting at the end of the radius, will probably, with the same twist and number of grooves,† have about the same amount of pressure per square inch as Whitworth's system, but will impede the velocity of the projectile less, owing to the smaller amount of surface under friction. The number of his grooves, however, can be increased to any amount, and thus the friction can be reduced to any extent desirable, a point of very great importance, as there is a limit, by the laws of practical mechanics, to the amount of pressure which should be given between surfaces in contact—700 lbs. per square inch.

With lead-coated projectiles, the whole surface would probably be under the action of friction to produce rotation, but, owing to the softness of the lead, and the difficulty of securing its proper adhesion to the body of the shot, I should be afraid to form any estimate of its value with very heavy guns. The longitudinal friction of the lead-coating in the bore is enormous, wasting on an average with very heavy guns about 10 per cent. of the useful effect of the gas—no other system, except Whitworth's, wasting nearly the same amount of the longitudinal pressure forward.

The Norwegian system is less capable of giving effective rotation. They could, however, easily increase the number of their driving studs. But, instead of doing this, they diminish the rotation, giving only one turn in 55 calibres; and with their large bores and tolerable centring they, I am told, get very good shooting.

Excepting, perhaps, lead-coated projectiles, the Woolwich studs are

* Whitworth claims a greater breadth of bearing surface than is here stated, but it is questionable if he gets more, because the pressure is obtained by the yielding of the metal to some extent, and this can scarcely be allowed for. Besides, any additional surface brought into play will act at shorter radius, and produce less proportionate effect in giving rotation, but more in giving friction. I think I have stated the case very fairly.

† The grooves, however, are here supposed to be deeper than those used by Captain Scott in his guns of smaller calibre, which are only ·125 inch deep. It is not necessary to consider the depth of Captain Scott's grooves an essential element of his system any more than the number. As the number increases, so may the depth without detriment. Whitworth, however, cannot increase the number of his grooves.

strained most severely, and I doubt not are often subjected to a strain of 20 tons per square inch, causing the studs to bulge. With proof cylinders an extra stud has been inserted in each longitudinal row, which materially increases the strength. The studs, however, are very much worn by the great friction, which must necessarily cause a greater waste of longitudinal pressure than if so much wear did not take place, as well as try severely the driving edge of the grooves.

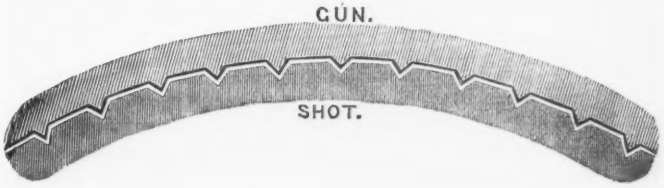
I have said nothing on the relative merits as regards centring by these systems of rifling, because I can scarcely offer an opinion. The best way of testing them on this point would be to fire through a number of paper screens at different distances so as to trace the trajectory, using at the same time the Bashforth chronograph to obtain the resistance of the air. The latter would give the amount of deflection of the point of the projectile, and the former the direction of the deflection.

I trust you will agree with me that I have done right in not speaking in terms of highest praise of any one of the systems of rifling which I have reviewed. I cannot assign the palm of undoubted superiority to any over all the others; each has its advantages and its disadvantages, and none are without objections. This is generally admitted, and has come to be thought a necessary part of all rifling. I am not, however, of that opinion, and shall now present you with what I have but recently come to consider a system which has all the advantages and none of the disadvantages of the systems I have noticed.

It may be briefly stated thus. Adopt the system of grooving in the Austrian B.L. experimental gun, but do not adopt the lead-coated projectiles. The lead-coated projectiles, in addition to the disadvantages I have pointed out, have the serious disadvantage, mentioned by Colonel Reilly, R.A.,* of being less effective against armour plates than iron projectiles, because the lead flies off on impact and does not help the projectile through the target. But, if we groove the projectiles so as to fit the projecting ribs of the gun, we do away with this objection, and we get an amount of bearing surface which alone meets the mechanical requirements of the case. I have adopted here 64 grooves in the shot, and the same number of lands in the gun, and, if we suppose them ·3 inch deep, we have an amount of bearing surface, which, under ordinary pressures, in a 15-inch gun, with a projectile of 1,200 lbs., and a twist of one turn in 40 calibres, would reduce the

* Notes of a visit to Berlin, December, 1872, by Lieutenant-Colonel E. Reilly, C.B., Assistant Director of Artillery, page 20:—"This lead covering causes a great "waste of power, as it is the iron part alone of the shell that can do work against "the iron plates, and consequently a considerable force is expended in projecting a "part of the projectile which is useless for the work which has to be performed." On this point Mr. Krupp remarks (letter 16th February, 1870), that the experiments at Tegel, 4th August, 1868, "again demonstrate that, in the case of the breech-"loading projectiles, a heavy lead-coating can so weaken the effect as to render it "insufficient." And Captain von Doppelmair, a strong advocate of Mr. Krupp, says, "We shall not be much in error when calculating the momentum of a lead-"coated shot if we only take into account the weights of the cast-iron or steel core" (pamphlet).

pressure below 700 lbs.* per square inch, the mechanical limit of pressure between surfaces in contact under friction. Here then is a perfect system of giving rotation. It does not cut into the bore of the gun, and therefore does not weaken it. And it will not wear the grooves, nor waste more than probably one-half of a per cent. of the longitudinal pressure of the gas, because with the small amount of pressure between the ribs and grooves, lubrication may be used. Practically, so far as rifling is concerned, both gun and projectile are everlasting.

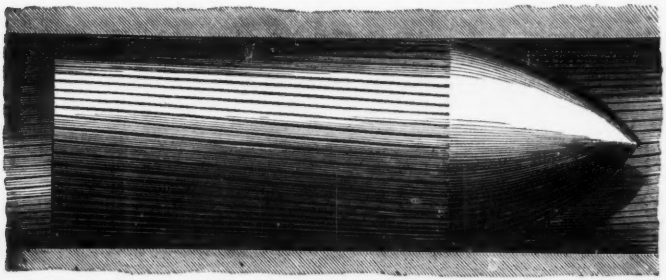


The following Table will serve for comparison of the probable pressures which produce rotation, and are wasted in friction, with the various systems of rifling. They are all calculated for a twist of 1 turn in 40 calibres, so that those given with Whitworth's rifling would have to be doubled for 1 turn in 20 calibres adopted by him. The pressures in *italics* are those due to exceptionally high pressures.

Systems of rifling.	600-pr. gun.				1,200-pr. gun.			
	Bearing surface inches.	Pressure on studs. Per sq. in. tons.	Pressure on studs. Total tons.	Longitudinal pressure wasted per cent.	Bearing surface inches.	Pressure on studs. Per sq. in. tons.	Pressure on studs. Total tons.	Longitudinal pressure wasted per cent.
Woolwich uniform twist	5	18	90	1½	7	26	180	1¾
Woolwich "	*5*	*45*	*225*	*2*	*7*	*65*	*450*	*2*
Woolwich 1 in 100 to 1 in 40	3	15	45	1½	4	23	90	1¾
Woolwich "	*3*	*37*	*111*	*2*	*4*	*58*	*225*	*2*
Woolwich 0 to 1 in 40 ..	3	20	60	1½	4	30	120	1¾
Woolwich "	*3*	*20*	*60*	*1½*	*4*	*30*	*120*	*1¾*
Whitworth hexagonal ..	120	2	240	4	170	3	480	4½
" ..	*120*	*5*	*600*	*5*	*170*	*7½*	*1,200*	*5½*
Scott	45	2	90	1½	60	3	180	1½
"	*45*	*5*	*225*	*1½*	*60*	*7½*	*450*	*2*
Lead-coating.....	—	—	—	10	—	—	—	10
"	—	—	—	—	—	—	—	—
Proposed rifling	240	⅛	90	½	540	⅛	180	½
"	*240*	*⅜*	*225*	*1*	*540*	*1*	*450*	*1*

* This is for ordinary pressures. With exceptional pressures, the same as in the other calculations, the maximum would be about one ton per square inch.

There are some other points which I may consider more in detail. It may be thought that the expense of cutting so great a number of grooves in each shot will be considerable, but I am assured, by a very able practical engineer and mechanic,* that this would not be the case, for a machine could easily be constructed which would cut them all in one operation.



But how about chilled projectiles? They can be turned and grooved, though it is more expensive to do so than with ordinary cast iron. I should, however, prefer to cast the shot in a cylinder of cast or wrought iron, and groove the outer casing thus formed. A wrought iron casing would be a very great advantage, because on striking an iron plate, the tendency of the body of the shot is to split in two, and fly forward like lead-coating, while the head jams in between the two pieces, but a wrought iron casing would prevent this.†

Another great advantage is that it could be used with breech-loading as well as with muzzle-loading guns. It is by no means an easy problem to solve how we are to secure that the projectile shall occupy its proper seat if we do away with lead-coating, because any arrangements made when the gun was new, might fail if the bore was worn out by scoring. It would be very easy to stop this scoring on this plan, by a wad, for the sharp edges of the ribs would readily cut into the wad and preserve the bore, or at all events the ribs themselves, from being eaten away. All

* On this point, Dr. Anderson, Superintendent of Machinery, War Department, observes in a letter to me, 12th May, 1873, "If the projectiles were to be done in "large numbers, so as to make it worth while to provide self-acting tools to act with a "number of cutting instruments simultaneously, the cost for wages would be very "trifling, requiring one quarter of an hour of unskilled labour. Of course, the size "would have an influence, but the cost would not be any barrier to the system if it "is right in other respects."

† Captain C. Orde Browne, late R.A., and Captain Instructor Royal Laboratory, in Proceedings, Royal Artillery Institution, vol. vii, page 25, says:—"The pro-"jectiles cast with sand bodies are superior in penetration to those entirely chilled; "because, as may be seen, while the pressure round the head towards a centre does "not test its tenacity, the base is in a very different condition. The metal then "having lent its force to some extent to the head, shivers away to the front, gene-"rally indenting the plate round the hole made by the head. Any increase of "tenacity in the material at the base is therefore clearly an advantage."

that would have to be done would, therefore, be to insert a few small zinc studs in a few of the grooves, and allow the projectile to go up until these studs come up to where the ribs terminated beyond the powder chamber. These zinc studs would probably afterwards aid the centring. The bore would thus not only not be weakened as in nearly every other system by narrow deep grooves cut in the most vital part of the gun, but would not wear out by scoring, and I have no doubt, if combined with the gun I had the honour to bring forward in this Institution three years ago,* that the endurance of our heaviest guns might be extended to 10,000 or 20,000 rounds. The use of a wad would not only stop the scoring but might also materially improve the accuracy of practice, if it prevented any rush of gas over the base of the projectile to produce initial deflection as the shot left the gun. With a breech-loading gun, the windage might be much reduced, and in all probability the shot would come out perfectly centred, for whatever advantage is to be gained by the principle of centring is to be found in this gun. And not only so, but the fact that a long gun is the only sure method of obtaining accurate practice could be taken advantage of, for, with a breech-loading gun, there is no limit to the length of the gun which can be made.

I have endeavoured to show, in a lecture recently given here to the Artillery Volunteers, that accuracy of practice at long ranges is what is now most required; and I may now add that, in the gun I have proposed, and in the rifling I have suggested, terrible efficiency at long ranges will secure to England that supremacy in naval warfare which, I thank God, has always been her prerogative.

The CHAIRMAN: Before asking any gentleman to offer any remarks on your paper, allow me to ask you what windage you propose to adopt in your gun as a muzzle-loader?

Captain MORGAN: I should propose the same as in the service gun.

Captain R. SCOTT, R.N.: With reference to what Captain Morgan has said as to the dropping of the shot just on leaving the gun, there can be no doubt but that he gives a perfectly true explanation of its cause. If the studs which are used in the Woolwich system—(to make my meaning clear I must speak of plans which have been tested)—do keep the shot in the centre of the bore so long as they retain their hold on the rifling; then, as these studs leave the support of the rifling before the rear of the shot has left the gun, it is evident from his illustration that the gas must push the shot downwards, and thus cause it to leave the gun unsteadily. The truth of this argument is confirmed by comparing the ranges of the 7-inch gun competition, in which my gun being fired with 20 lbs. of powder, and the French gun, or as it is now called the Woolwich gun, with 25 lbs., both at 2° of elevation, the shot dropped at about the same distance; in fact, my gun had rather a longer range than the Woolwich, although the initial velocity of the latter was, with this much larger charge, greater. Now what had the stud-shot been doing not to have ranged further? They had been gyrating in the air, very much as Captain Morgan has shown in the diagram; in fact the shot, instead of rotating only round their axes, had been also circling round and round like an unsteady peg-top. I do not quite agree with what Major Morgan has said as to the cause of the deviation of projectiles, but I think he has exactly illustrated it with the gyroscope, by hanging a weight on one side. It is the heavier weight in the rear, or, in other words, the centre of gravity being in

* See *Journal*, vol. xiv, p. 479; and vol. xv, p. 335. A model of this gun may be seen in the Museum of the Institution.

the rear of the transverse axis of the figure that causes the shot to deviate from a straight to a curved path across the vertical plane. To my own mind the reason is plain, and probably it may be made clear to others by this explanation. The larger and heavier circle of the rear of the shot has a greater tendency to maintain rotation than the narrower and lighter circle (section) of its front; and as this front part has also less tendency to maintain its onward momentum, the rear is as it were pushing the front aside in its endeavour to get first. These forces result in the shot's describing a curved path in the direction of its rotation, and the longer the flight, the greater is the shot's deviation. As illustrated by the gyroscope, the shot does not deviate much at first, its rotation being considerable, but it deviates very considerably towards the end of its flight when its rotation is much lessened. Captain Morgan has spoken of the grooving as liable to cause the splitting of the tube into which it is cut, from the unequal stretching of the inner tube by the fired gunpowder gases. I think he has over-estimated this effect, and as my gun has been referred to by him, I can, without entering upon new ground, speak directly to this point. If the grooves of any gun—and, as is the case in the gun proposed by Captain Morgan—be only about ·3 of an inch in depth, the tube of the gun cannot be injuriously cut into. In my 7-inch gun, the depth was ·125 inches, and ·135 of an inch would be quite enough for the heaviest gun rifled on my system; the steel tube, however, instead of being little more than ·125 inches thick, is in reality 3 inches thick, and therefore such rifling would remove but a very small portion of the inner surface of the tube, and would not, in my opinion, materially lessen its strength or interfere with its equable stretching. I do not think that the grooving, *per se*, has ever been found to be one of the causes of the failure of our wrought-iron guns. Experiment has shown that the principal cause of failure is the scoring of the upper surface of the bore from the rush of the gas past the shot; this gradually eats away and weakens the tube, preparing it, as it were, to give way at the places where it is struck by the projectile. This striking action is very intense in the Woolwich gun, for the upper portion of the charge being first ignited, the pressure of the gas falls upon the upper surface of the shot, and the lower studs at once yield to its force; the consequence being that the dropping of the shot to the bottom of the bore allows a great rush of gas over it, and it prevents the rising and centring of the shot. Hence, as the studs interpose but little check to the rush of the gas, and the grooves are large, the wearing effect upon the whole upper surface of the bore of the gun is very great. You come back, then, to these points—you want to stop the injurious rush of gas, and you want to raise up the axis of the shot so as to centre it in the bore of the gun. As regards the centring, I believe it is admitted, as Major Palliser stated in his treatise, that I first pointed out the principle of centring the shot. I think there is no doubt that my plan really does centre it. I beg you to bear in mind that the ribs (bearings) of my shot are continued throughout the cylindrical portion to the end of their base, which is flat, but in the present projectiles the studs are near their centre, and the base is rounded. You could not have a worse form than this, because the gas impinging against the rounded end must have a wedge-like action over the top of the shot which greatly accelerates the cutting or eroding of the bore of the gun. By using studs and the gaining rifle twist, you do away with length of bearing, and hence, before the shot leaves the bore, it is wholly deprived of the guidance of its projecting studs, and necessarily has that great tendency to deviate which Captain Morgan has pointed out. I have no doubt we shall have to come back to the flat base, for the present rounded base of the shot greatly adds to the difficulty of checking the gas, by wads or other means, so as to prevent erosion of the bore. A great many wads have been already tried, but none have been successful, for if the wads be large and tough enough to resist the action of the gas, they would be exceedingly dangerous on board ship, because the wad may fly to the right or left, and do considerable damage to neighbouring ships or boats. Wads, unless they break up close to the ship, are, I think, very objectionable. I am much obliged for the very favourable table which has been brought forward by Captain Morgan. I really had no idea before that the comparisons were so favourable for my system as he has shown them to be; you will see in the second column the relative pressures. With the uniform twist and the Woolwich studs it is given as 18 tons per square inch, and 45 tons per square inch when the pressure has increased to its maximum, but

in my plan the pressure is shown to be 2 tons only, and 5 tons when increased to its maximum; so that, according to this comparison, my system of long bearings has a very great advantage over the service plan of studs. An article on the pressures upon the studs of our service projectiles, from the pen of Captain Noble, is correct in theory but incorrect, I think, in practice. Captain Morgan gave an illustration of this when he pointed out that the studs of the projectiles fired from the 35-ton gun became partially sheared, and that then these studs slipped over the edges of the grooves, tightly jambing the projectile between the lands of the bore of the gun. I think in this explanation we have a solution of the enormous powder-pressures obtained in the first 35-ton gun, for the wedging action must have retarded the shot and tended to increase the powder-pressures. The correctness of this solution is confirmed by what Captain O'Hea recently told us as to the effect of friction in retarding the shot. He stated that by boring out the rifling to within a few inches of the muzzle of a rifle-barrel he got a very much higher velocity than usual, owing to the bullets travelling through a smooth bore until they got close to the muzzle, when there was a little retardation, from the bullets having to cut their way past the rifle grooves. Captain O'Hea's last experiments are still more conclusive as to the retardation caused by friction; these were made with bullets so small as not to touch the rifle grooves, the paper wad alone taking the grooves and giving the necessary spin to the bullets, the result was that he obtained 150 yards more range with the same elevation. May I ask Captain O'Hea how much this is in excess of the service weapon's range with equal elevation.

Captain O'Hea: 225 yards at 700 yards range, that is, I use the elevation for 475 at 700 yards.

Captain Scott: Therefore, this experiment brings out in a very remarkable way what must be the result if the projectile does not easily slip out of the gun. Theory does not teach this remarkable result, but it is found in practice, and I am satisfied from the results that I have seen, and from observing the markings in the bore of the gun, and other indications, that when the first rush of the gas comes upon the stud-shot its rear is pressed violently downwards, and strikes a heavy blow upon the bottom of the bore. The shot then rubs along the bottom, and there is a tremendous amount of friction in pushing its way through the fouling which lies there. This rubbing causes an irregular motion, tending to tilt the shot, thus increasing the retardation, and further adding to the irregularity of the powder pressure throughout the whole distance of the shot's passage through the bore of the gun. The consequent loss of velocity is very considerable, and resulted in that, of all the 7-inch competitive guns—the Woolwich gave by far the lowest initial velocity. I think I have now touched upon the points which concern our present system of rifling in so far as Captain Morgan has gone with his proposals, and, therefore, I will say nothing about weakening the shot, and the consequent danger to the service gun, but only add, that although Captain Morgan has so ably brought before us many new considerations, as to the best mode of dealing with ordnance, and his gun is exceedingly ingenious, I do not think that his rifling would be found upon service to be advantageous. The great number of grooves would always be an objection to it, and I think that the fouling would lie in the small grooves, and that he would find that practically there would be a very great increase in the friction without corresponding advantages. I am satisfied, as I said before, that his proposed wad would be objectionable; and I do not think that he would find that the grooves in the shot would be cut so easily as he supposes. They would have to fit the gun with the greatest nicety, a nicety that I do not think could be ever carried out in practice; and, therefore, although Captain Morgan's is an exceedingly ingenious rifling,—and I quite agree with what he says as to the importance of centring the shot (as I believe all who have studied the question must do), and have learned a great deal from his paper,—still I cannot think he would get those practical results from the use of his rifling which, I for one, should be very happy if he succeeded in obtaining.

Commander W. Dawson, R.N.: This is the first time I have had the honour of meeting Captain Morgan face to face, but it is not the first time I have derived benefit from his valuable instruction. I have to thank him for the profitable reading in some very instructive papers of his, and I thank him very much for the very

intelligent and very scientific explanation he has given us to-night of the rotation of projectiles, and their gyrations in the air. The explanation he has given, based as it is on the gyroscope, appears to me very similar to that we taught fifteen years ago, when I was an instructor in gunnery, as to the cause of the deflection of the Armstrong projectiles. The whole gist of the paper appears to me to resolve itself into the means of obtaining increased accuracy. That is a point which is of far more importance than at first sight, perhaps we naval men are apt to think accuracy has risen very much in importance, in consequence of the unequal distribution of armour in different thicknesses over the ship. When a ship was covered with the same thickness of plating in all parts, she was equally vulnerable or invulnerable, wherever she might be struck, and it did not matter very much what part of the ship was struck; but when there is a patch of 12-inch armour here, and a patch of 10-inch there, and so on, it becomes of the very first importance that you should know what is the particular point that the special gun you happen to be firing can perforate, and what is the part it cannot penetrate. It is even more important to know the spot it will not, than the part it will. You want that information not only for the larger guns, but for every sized gun in the ship. I believe that in the case of one ironclad attacking another, there is no reason why every nature of gun should not be very effectively fought if we had but the requisite skill to plant each shot in the place, the vulnerability of which is adapted to its penetrating power. Therefore, precision of fire appears to have risen very much in necessity since ships have lost their homogeniety of resistance. I point out this the more readily because I think that the principles laid down by you, Mr. Chairman, some five years ago, as to the requirements of good naval guns still hold good, and it is well, I think, to call attention to what those principles are, again, to re-state them in order that we may see how far they are applicable to the various systems and weapons which are brought before us. Admiral Key laid it down that the first and most necessary quality in a naval gun is that, it should have strength and endurance; second in importance, penetrating power up to 1,200 yards; third in value, the use of a powerful shell; fourth in estimation, simplicity as regards non-liability to derangement, and facility of working in the gun, and in the projectile; fifth in essentials, *accuracy with a low trajectory*, especially at ranges under 1,500 yards; sixth, and last, extensive range, which quality, as Admiral Key points out, is not a necessity for naval ordnance. Now, although it is possible that if Admiral Key were writing that minute now, he might alter some portions of it, yet I think the order in which he has placed those qualifications remains still very much as it was in the year 1868. And although accuracy is put down as fifth in importance, you must remember that so far as precision of fire is dependent on the weapon itself, and not upon those who employ it, it is connected with flatness of trajectory, which means high velocity. But high velocity from the same muzzle-loading gun under similar circumstances has a most beneficial effect upon Admiral Key's most important requisite endurance; because the higher velocity under like conditions, evidences that there is less resistance to the escape of the shot, and if there be less resistance, it indicates greater steadiness of flight through the bore, and therefore, fewer dents, abrasions, and enlargements, and consequently better endurance. Further than that, greater steadiness in the bore by giving higher velocity, implies also increased penetrating power which is Admiral Key's second important quality. So that the question of steadiness of flight which has been brought before us so ably by Captain Morgan to-night, whilst it apparently deals only with precision of fire, is dealing with the far more important qualities of endurance, penetration, and shell-power, and opens up a very large question involving many other considerations than those which are specially pointed out. Now, seamen are apt to underrate accuracy because they have certain physical difficulties in practically attaining it, and they do not face those difficulties with a determination to overcome them, as perhaps they ought to do. There are, first, the difficulties connected with our ignorance of the distance, and of the results of our fire. Generally speaking, very little trouble is taken in finding out the distance of the object, and we are commonly ignorant of the results of our shooting. Very little pains is taken to place observers at right angles to the range to watch where the shot falls. The evil influence next in importance is that the front and rear sights are placed too close together, especially in the

rifled guns; and, third in importance is the low velocity, and, therefore, the high trajectory due to our present system of rifling. Captain Morgan has well pointed out that the 40-pounder breech-loading gun was one of the most accurate guns we ever had. But when the 40-pounder was put on the broadside of a rolling ship, and worked alongside the old 68-pounder smooth-bore, "the old 68" beat it hollow. Why? Simply for the reason I have pointed out, that we do not take pains to ascertain the distance; the sights in the 40-pounder are too close together; and, thirdly, lead-coated projectiles have very low velocities, and, therefore, high trajectories as compared with the 68-pounder at fighting ranges. Though precision of fire depends mainly on efficient gunnery training, yet, so far as it is dependent on flatness of trajectory, it depends upon getting the point of the shot to face its work accurately in the air. This really resolves itself very much into what occurs within the gun, in obtaining perfect rotation, and correct centring in the bore. But those two things, rotation and centring in a M.L.R. gun, are also connected again with reduction of resistance, and, therefore, with velocity. Wherever in a windage gun, a proportionately high velocity is not obtained, it is because there is a misapplication of force absorbing the propelling power, some extra resistance resulting either from the lack of coincidence in the axes, from wedging over the lands, or from some mechanical obstruction to exit, acting within the gun. The *Pall Mall Gazette*, which seldom admits anything wrong in our present guns, has pointed out that the French breech-loading rifled field-pieces give about 600 feet more initial velocity than our English field-pieces. The German field-pieces give, it says, 300 feet more than the English field-pieces—the 9-pounders; and we know from some experiments that were made by Mr. Vavasour, at Woolwich Arsenal last November, that he got 1,600 feet of velocity from his breech-loading 10-pounder there as against, I think, it is about 1,300 feet in the service 12-pounder gun. Now, although it is quite true that all this increase of velocity and flatness of trajectory does not take place in consequence of the non-centring of the shot, or the imperfect rotation, yet there is no question that that increased velocity could not be obtained under any circumstances from the Woolwich balanced-system of rifling. From the French competitive trials between a Woolwich M.L.R. 12-pounder gun, and a Vavasour M.L.R. 12-pounder, identical in all respects except the rifling, it appears that 16 feet of initial velocity is the amount absorbed by the short-bearing balanced shot in its efforts to escape from such a Woolwich gun. The want of velocity in our balanced stud system is made still more apparent when we compare the performances of the cast-iron gun of the French of 34-tons as against the beautiful wrought-iron 35-ton gun of Woolwich. The striking force of the cheap French gun is one-fifth greater than that of the costly Woolwich gun. Now, there is one striking fact—take that home! The figures are publicly stated and not contradicted by that generally very well-informed Artillery authority, the *Pall Mall Gazette*, the articles in which are supposed to be written by a well-known Royal Artillery Officer, who is generally very well informed on all these matters. The difference of the striking force amounts to 1,625 foot tons in favour of the French "infant," which is in fact as if they were firing an extra 7-inch 6¼-ton gun. This absorption of force affects endurance very much. Wherever there is extra resistance to the shot escaping, there must be extra work done upon the gun that ought to have been employed in driving the shot forward. The reason is very plain. If the shot is not correctly centred, it must, as Captain Morgan very well calls it, "knock" the bore of the gun in its passage out, and the consequence is, that every projectile is so injured in its efforts to escape that, if recovered, it has to be re-cast, whilst the bores are abraded, dented, and enlarged, so as to demand examination after every fifty discharges. Indeed, I find in the recent "Manual of Naval Gunnery," published this year, the following statement with reference to endurance: "The "under-mentioned table, showing the number of rounds which have been fired "from some of our heavy muzzle-loading rifled guns proves that their powers of "endurance are most satisfactory. 12-inch M.L.R. gun (of 25 tons) 359; and, "another, 200 rounds. 10-inch M.L.R. gun, 534 rounds. 8-inch M.L.R. gun, "433 rounds; and, another, 408 rounds." The 35-ton gun is not mentioned, though it fired its last round a year before the publication of the "Manual of Gunnery;" it fired, however, 38 rounds from its 12-inch bore and 35 rounds

from its 11·6-inch bore, before it gave way. The "Manual" does not say what charges of powder were fired, nor with what elevation, nor what interval of time elapsed between the rounds? How many years were occupied in these discharges is also not stated. I think the Navy needs something more than second-hand knowledge of what our military gunmakers have done, and should buy its own experience of its own weapons. The Navy itself has had no practice with these heavier guns, with the 12-inch guns; and whatever we read in the "Manual of Gunnery" for Her Majesty's Fleet, is derived from confidential blue-books, and other publications prepared by our military brethren from time to time at Woolwich Arsenal. Amongst the many verbatim extracts made from Woolwich books and inserted in the "Manual of Gunnery," there is abundant information as to the dents, abrasions, enlargements, and other defects which occur in the guns, and instructions as to the frequent, periodical, and minute examination and registration of injuries, consequent upon what Captain Morgan calls the "knocking" of the shot in the bore, not that the three pages of instructions as to the registration of injuries are wholly taken up with those defects which are necessarily of a very serious character; but most of the injuriesi nflicted by the projectiles bear testimony to the fact of that oscillation of the shot in the gun and non-centring, which accounts for the deficiency of velocity and perforating power. This deficiency of steadiness in the bore influences the accuracy of fire, chiefly by causing a high trajectory instead of a flat one. The deficiency of steadiness, and thus of velocity causes, therefore, a loss of accuracy, of endurance, and of penetrating power, and all the ills to which gunnery flesh is heir. Thus, perfection of rotation with the minimum of resistance, resolves itself into an increase of velocity with a given powder-charge and shot. As to the plan which Captain Morgan proposes for overcoming these difficulties, I quite agree with what was said by Captain Scott, that a multitude of grooves in a muzzle-loading gun which is to be fired with an iron shot, would be open to some practical objections. The fouling might lodge in the small shallow grooves, and cause some difficulty in loading. There must also be a sufficient depth of grooves to allow for necessary windage. Windage is essential in all iron-bearing guns to allow for the expansion of the bore, for difficulties of manufacture, and for the presence of fouling matter, and so on; and where you have a multitude of very shallow grooves, you must have a soft lead-coated, or lead-expanding shot. These are not crucial objections to a scheme which has much to recommend it, in that it gives enormous rifle-bearing surfaces, and that it supports the shot along its whole cylindrical body, diffuses the effort of rotation over a large portion of the bore, and remedies many of the existing defects by steadying the projectile in the bore, and getting rid of that system of balancing the shot in unstable equilibrium upon two studs nearly under its centre of gravity. I should be glad to get further information on this long-bearing system, and especially as to how it is proposed to obtain the centring, for of course, however long and rigid the rifle bearing, correct centring must be an essential part of the system. Captain Morgan has adopted I am happy to see an iron-bearing, and has come to the long-bearing. These are two most important concessions to common sense and experience. But I should like to know how he obtains the centring. These are the great wants of our present guns—long iron rifle-bearings, and correct centring. Adopting those two principles, we shall practically obtain all the advantages that rifling can give to diminish the resistances, and thence to increase the velocities of similar shot, and it is in this direction we must look for that which Captain Morgan seeks, viz., an increase of accuracy in artillery shooting.

Captain MORGAN: I must say in reply that I am very glad to find the tolerably favourable reception which has been given to a new view. I came here very dispassionately on this point, and with a view to provoke discussion, and to see what really was the result on the mind of the members of this Institution. I know that very serious objections are taken by some officers in the Navy to the Woolwich rifling; and, however satisfactory it may be so far as it has gone, I think, unless we increase the bearing surface, if we go to heavier guns it will fail, and it is better to consider the subject now, than to consider it after it has failed. In the Royal Laboratory, as Captain Sladen will be able to tell you, they are gradually coming to an increased number of studs, and I am sure he could bear out what Captain Scott

says about the rubbing along the bottom of the bore. I know he has been studying that matter, and perhaps he will be able to give us the results on some future occasion. It is principally to obviate that objection, that I am so decidedly in favour of the wad that Captain Scott takes objection to. If however he will show me any other way of stopping the windage—which windage drives the shot on the bottom of the bore—I shall be very happy to adopt it; but I see no way of doing this, except by stopping the windage over the shot. In the first place, the rush of the gas scores the gun at he has justly observed, and in the second place, it drives the shot on the bottom of the bore, and I would only ask why does Captain Scott object to a wad? I quite agree with him about the flat base, and I have drawn my shot with a flat base, and the only reason why I have put a *big* wad in that sketch is, that you may be able to see it at a distance. It may be any size you like so long as you stop the windage. I must say a word against a misconception about powder pressures in heavy guns. I know something about gunpowder, being Assistant Superintendent in the Royal Gunpowder Factory, and I can see that several officers have been misled, and Commander Dawson is one, as to the causes of these powder-pressures. It seems to have got abroad that the jambing of the shot in the bore is a cause of the intense powder-pressures. I am perfectly sure that the powder itself is sufficient to give the results observed, that is to say, if a powder maker makes one brand of powder and then sets about to make another exactly the same, he may feel perfectly sure he has done so, but he may fire one brand in a 35-ton gun with 25 tons pressure, and the other with 65-tons pressure. Why therefore put down to the studs what is sufficiently accounted for by the powder? We are trying as well as we can to get the powder uniform, and this is one of the most difficult and one of the most important things we have to do. I do not think we have quite solved the whole question yet. I think we must go further into the question of powder for big guns. All pebble powder is proved in the 8-inch gun, but we may have two powders which may give the same pressures in the 8-inch gun, but when fired in the 35-ton gun, one may give double the pressure of the other. I am not particularly bigoted about this system of grooving, but I have had the misfortune to invent a breech-loading gun, and to think that it is the best gun that can be adopted. As was said by the last speaker, the first element in a gun is strength; the first element in this gun, I say, is strength. It is from two to three times as strong as a muzzle-loading gun, because I have taken off the strain which tears the gun longitudinally, and when that is taken off, there is opportunity of applying the metal, so that the gun shall be as strong as possible. To do this, involves that the gun shall be breech-loading, which may be or may not be a misfortune, but strength is the main element. Having got this gun, I had to consider how it should be rifled, and I could not for a long time make up my mind. At first I adhered to the usual system of lead-coating, and here I advocated that system as possibly the best, but Captain Scott completely upset my ideas on that point. Since then I have gradually come round to his views, and have given up the idea of lead-coating. Now I think these ribs are probably the best, and I have gone a little further than Captain Scott, so as to meet all the requirements of the case. With regard to the use of this system with muzzle-loading guns, the objections that hold with regard to muzzle-loading guns of course do not hold with regard to breech-loading guns, that is to say, the fouling of the bore does not take effect at all with the latter. If the gun fouls, the shot will clear it out the next round, but if there is any chance of its not having sufficient play, we have only to make the ribs a little deeper, and to make the grooves a little larger, so that they might even have half an inch play laterally and as much as you choose the other way. Unless you have a breech-loading gun, I do not see how you can have a gun sufficiently strong,—and if you adopt a breech-loading gun, what rifling are you to use? I hope whoever takes up the subject, after he has puzzled as long as I have, will arrive at a satisfactory result. If you have a gun that has windage, as soon as you fire two thousand rounds the bore is worn, and there will be no grooves at all. Stop the windage and you will make the gun everlasting. If our Snider and Martini-Henry rifles can fire 20,000 rounds without the slightest difficulty, why should not our big guns be able to do the same. I go in for strength and endurance. We are very much indebted to the last speaker for what he said about accuracy of firing. I believe it is not properly appreciated. If we have to fight a ship a long way off, the

further off we can sink her, the better. We have our torpedoes now-a-days, and they can be driven under water for half a mile, and perhaps we may get them to drive further. Now it is much better to sink your enemy before he can come near you with his torpedoes. That is my view, but of course I would not venture to speak for the Navy. I do believe that accuracy of fire is what we are coming to, and this will make quite a revolution in artillery. The old style used to be to get as close as you can, to fire off your guns, and the gunners who stuck the longest to their guns, were those that won the day. But now it is science, and long distances and accurate practice that are wanted. I am very much indebted to the last speaker for having pointed this out so well. He also asked me how I expected to get my centring. I only quote Captain Scott on that point: he says "with this system of centring, it (the shot) will centre itself." That can be carried out in this system. It has a bearing surface that will not yield, and therefore the shot will probably centre itself. I provide, however, for more than that. If there is any knocking, it will come on the base, and the base is the last point that leaves the gun. I should therefore put zinc studs in some of the grooves at the base; these will jamb along the top of the rib, and so keep the base perfectly steady the whole way, and insure that the projectile leaves the bore perfectly centred. I am not prepared to go into the statistics mentioned by Captain Dawson about the velocity and endurance of guns. I know we can get sufficient velocity in our guns; we can give a very high velocity. But it is a question of strength combined with velocity. We can make a powder that will give 100 feet more in the heavy guns than is done, but it is very questionable if the guns would stand long at that rate. And I am rather doubtful about the *Pall Mall Gazette;* I am afraid it is rather biassed on the points that have been taken up. I rather think that we have the greatest velocity in our guns, that we have stronger guns than those on the Continent, and that we have greater penetration than any gun in the whole world. But I do not think we have come to the end of the matter yet, for we shall have to go on to bigger guns, and then I believe our present system of rifling will not do. In conclusion, I may say my object was to have a good discussion, so that opinions might be ventilated, and this subject might be approached with all the intelligence and foresight that is possible.

The CHAIRMAN: I am sure that all here present will wish me to return our thanks to Captain Morgan for the very interesting paper he has read to us. It is very desirable that the subject of this evening's paper should be thoroughly discussed before we proceed to incur a vast expenditure in building heavier guns than we have at present. Our present system I believe to be the best established in any country, but it is not without its defects. As regards the gun that Captain Morgan has proposed, I cannot help concurring in the opinion expressed by Captain Dawson that these very narrow shallow grooves are liable to foul and to offer serious difficulty in loading, if it is intended to be a muzzle-loader, and the zinc studs at the base of the shot will add to that difficulty. (Captain MORGAN: They are applicable solely to the breech-loading gun.) If the system is intended for a breech-loading gun, it seems to me to offer many advantages. It has a long bearing, and the mode of centring the shot appears satisfactory. The windage also in that case can be reduced to a minimum. Captain Morgan said he was "unfortunate" enough to propose a breech-loading gun. I can only say that in my opinion (and I think I express that of the Navy in general), if you will give us a good breech-loading gun, we shall only be too thankful. It is just the thing we wish for, but it must be a good breech-loading gun, free from the defects of all hitherto tried. It is an object much desired by the Navy. One very interesting part of the paper, to my mind, is that table that Captain Morgan has explained to us, showing the different pressures on the bearing surfaces of different descriptions of guns, and the pressures on the studs, especially as bearing on that interesting question of the uniform and increasing twist. But there is one point that I think has not been considered this evening. The principal advantage claimed by the advocates of an increasing twist, is that it adds to the endurance of the gun by equalising the pressure of the gas during the passage of the shot through the bore. I am glad to hear that experiments are going to be carried out to ascertain what the pressures are with the uniform twist and with the increasing twist, and I think that the experiment will be a most important one. If it shows that the pressure with the increasing twist is more uniform during the passage of the shot through the bore, it

will be an important point to the advantage of the increasing twist. Captain Morgan has shown that the pressure on the *studs* is of no great importance; that in the uniform twist, although you have a greater pressure on the stud, yet by increasing your bearings you nullify the disadvantage so far as the studs are concerned. But still, I think, we must wait until we hear the result of the experiments on the pressures on the gun. I beg to offer Captain Morgan the thanks of the meeting for his very interesting paper.

LECTURE.

Friday, June 27th 1873.

GENERAL SIR WILLIAM J. CODRINGTON, G.C.B., in the Chair.

ON THE BEST MODE OF DEFENCE OF THE PROTECTED TERRITORIES ON THE GOLD COAST OF AFRICA, AND THE ORGANIZATION OF A FORCE SUFFICIENT FOR THAT PURPOSE.

By Admiral the EARL OF LAUDERDALE, G.C.B.

WHEN I drew up this paper, I was under the impression that all the tribes between Cape Coast and the Ashantee frontier, were under British protection, but there have been laid before Parliament important papers relative to the state of affairs at Cape Coast, which show that, before the Ashantee invasion, matters were in a very unsettled position, and from which it is difficult to make out whether there is really any protectorate at all; but as it is clear that we collect a revenue from the tribes, it appears to me that we are in honour bound to protect and assist them; otherwise I should not trouble you with this paper.

When I read, in one of the evening papers, about three months ago, that the Ashantees had invaded our Protectorate by crossing the Prah river with 12,000 men, I thought it would be a very serious affair, and in my place in the House of Lords, I urged the Government to take immediate steps to prevent supplies of arms and ammunition from getting into the hands of the enemy (the Ashantees), and to collect a sufficient force without delay, as we had, at that time, only one company (2nd West India) and a few Houssa native police to defend the eight or ten forts along the coast under the British flag, and also knowing that the tribes on the coast from the Gambia to Lagos, were in an unsettled state. I believe the great cause of discontent amongst the Fantee tribes was our handing those tribes over to the Dutch by Treaty in March, 1867, against their wish. This caused much bloodshed; but by the last Treaty of February, 1871, they are all again under our so-called protectorate, but it appears they are given to understand that they must fight their own battles and that we will not protect them against the Ashantees: I am not here to discuss the policy of the Government in withdrawing all our troops from the Colonies and protected territories, but I will say this, that the force should not be withdrawn from any colony or protected territory until we are satisfied that they have organised a sufficient force to defend themselves from any impending attack.*

Before entering farther into the subject, I will give an outline

* Two years ago, our colony at Bathurst, River Gambia, was so unprotected that they were obliged to call in the assistance of the French.

SKETCH-MAP OF PART OF THE GOLD COAST.

Journal R. U.S. Institution, Vol. 17 Plate XXIV.

Stanford's Geog. Estab.t 6 & 7, Charing Cross.

of the protected territory on the Gold Coast of Africa. It is bounded on the east by the Volta, on the west by the Assinee, on the south by the sea, on the north by the Ashantee territory; the River Prah being the line. Latitude 5° to 6° north, longitude 1° to 3° west. Population about 400,000; area, 14,000 square miles; sea coast about 250 miles, along which there are now ten forts under the British flag. Rivers—Volta navigable, Assinee not known, Prah, Seicoom, and several other small rivers which are fordable in the dry season. Water is scarce, except from the rivers, but can be got by sinking ten feet. Country is level, in general covered with impassable jungle, through which all roads must be cut: there are no wheeled carriages or beasts of burden in the country: products, gold, ivory, and palm oil.

The revenue in 1870 was 36,000*l.*; imports in 1871, 500,000*l.*; exports, 400,000*l.*; but, I believe, it is all much increased since the Dutch Settlements were handed over to us.

The principal towns on the coast are Axim, Dix Cove, Bootry (fort), Secondee, Chama, St. George, or Elmina, Cape Coast Castle, Anamaboo, Accra, and others: the towns in the interior are shown in the map.

The climate is very hot, but considered more healthy than that of Sierra Leone. Winds, generally along the coast, from west to east; rainy season from May to August. There are also occasionally tornados and hermattans.

There is anchorage all along the coast.

The Ashantees are known to be a warlike tribe, and it is said that they are, in a considerable degree, organized into regiments or distinct bodies, under their own Officers, whom they strictly obey; they are well armed. Their mode of warfare is peculiar; they seldom attack our forces when in large numbers, but wait to be attacked, when they do not make a determined stand, but make a sham retreat, and when their enemy is drawn from their position, they turn and attack them on the flank and rear.

The Kingdom of Ashantee, North of the Gold Coast, is thus described by Sandeman in 1837:—

"Its general appearance is beautiful, many parts resembling a "gentleman's park; deer, hares, partridges, wild ducks, pigeons, &c., "are plentiful, but beeves and horses are scarce; it is also very rich in "gold, and populous. The natives are well made, but are a barbarous "and deceitful people, more inclined to be warlike than commercial; "they have no written language, but are famous for making long "speeches in debating on any subject. The King is a very powerful "chief, he has upwards of 200,000 warriors, and has full power over "the lives and liberty of all who offend him, and his authority "extends over several neighbouring states; the capital is Coomassie."

This is the fourth or fifth war we have had with the Ashantees, or rather the fourth time they have invaded the territory under our protection: the first, in 1807; the second, in 1824, when Sir Charles MacCarthy lost his life; the third, in 1853; the fourth, in 1863, serious; and the fifth, in January, 1873, this present invasion, which was not sudden or altogether unexpected; for early in December last year the Kings and Chiefs of the various tribes near the Ashantee frontier (the Prah river)

sent urgent messages to the Administrator for help and protection against an impending attack by the Ashantees, who they declared were preparing against the Assins, Abrahs, and other nations of the protectorate; their sons and relations came saying that the Ashantees were collecting large forces on the other side of the Prah river. No attention however was paid to them until January, when a patrol of police was sent to the frontier, who on the 30th of January returned and confirmed the statement that had been made by all the Kings, and that the country was actually invaded by a large force of Ashantees; that the Kings and Chiefs had no means of defending themselves, having no ammunition or guns. Even then, it was some time before these supplies were given them, and only in very small quantities, although the enemy was burning the villages and murdering the population of a vast tract of country, which they had already seized up to the 30th of January. The King of the Assins sent to the Administrator on this date, saying: "You have sent me word that the King of Ashantee is the very "good friend of your Queen and of yourself and that he cannot mean "war, but I tell you this is war; the Ashantees have crossed the Prah "river and have penetrated 12 miles into my country and have burned "nine of my villages and murdered all the inhabitants, except those "they have sent into slavery in Ashantee. I wait no longer for your "orders, but go to fight my enemy and defend my country." In short, until after the battle on the 10th March, no assistance and certainly not a sufficient supply of ammunition was given to the native tribes. This, I believe, to have been the chief, if not the sole cause of their defeat, and in this I am supported by the following:—

Circular to the Foreign Ladies residing at Cape Coast Castle, March 13th 1873.—"Dear Friends, news having been received from the camp "of the rapid advance of the Ashantee forces invading the Protectorate "States, and it being imperatively necessary that speedy and immediate "measures be adopted for repelling the invasion, the native ladies of "Cape Coast have resolved on levying amongst themselves contributions "for the purchase of munitions of war and arms, in order to aid the "fighting men in re-taking the field against the enemy, and therefore call "upon the foreign ladies residing here to lend their pecuniary assistance "according to their ability."

"£150 has been collected. The Ashantees, 30,000 strong, are within six hours' march of Cape Coast."

Up to the time of the second battle, 150 barrels of gunpowder had been given them, being only about twelve charges for each man, the force being forty thousand.

The first battle was fought on the 10th March, 1873; the Ashantee forces are supposed to have amounted to 30,000 men, armed with muskets, but no artillery; the forces of the various Chiefs and Kings under our protectorate were calculated at about the same number, viz., on the right of the line, first, the Buaffoos, under King Edoo; Inkooskooms, King Essandoh; the Assins, under their King; to the left were the Abrahs, Anamaboos, Dankara, and part of the Assins, under King Chibbo, and Inki, one of the Kings of the Assins; the Gomoahs—a large tribe.

The first shot fired by the enemy was against the Abrahs, who returned the fire, and continued to fight most gallantly under their king. After the first volley into the Abrahs, the enemy commenced an attack on the whole line, where they met with a stubborn resistance, and the battle raged furiously for several hours from right to left, the Ashantees being well led by their chiefs, and our forces being no less so by their Kings; all of a sudden, the firing on our right flank began to slacken, whilst that of the enemy had in no way abated; this was caused by a panic, which had seized the Cape Coast men, who believed the enemy had outflanked them, and King Edoo, having been unable to maintain his position, had withdrawn his forces from the field. Nothing could induce the Cape Coast men to remain at their post, and they rushed back to Cape Coast, bringing the news of the defeat of our forces, but such was not the case; at that time, the Abrahs and Anamaboes and others were still fighting bravely against terrible odds, their kings and leading men each vying with each other who should outdo the other in bravery, but, by the withdrawal of the Cape Coast men, and the retreat of King Edoo with the people of Buaffoo, our line was open to attack from rear and right, the Ashantees having taken Yancoomasie, which was the key of our position; the Houssa force, which was in the rear, did not assist. It was now getting late, the Abrahs and Anamaboes still holding out, although nearly enveloped by the enemy, but it was all to no purpose, their *ammunition failed* them, and they were obliged to retreat, and the Ashantees pressed on and got possession of our camp; meanwhile, as the battle was raging, part of the Assins under Inki on our right, and the remainder of the Assins and Buaffoos on our left, who had taken but a slight share in the action, had stolen into the rear of the Ashantees, and plundered their camp and carried off a number of prisoners; this prevented the Ashantees from following up our retreating forces; thus ended the first battle. The second battle was fought on Easter Sunday; our forces were posted (as shown in the sketch) occupying a half circle of about ten miles, and advanced along their war paths; they fought well for six or seven hours, and at first drove back the Ashantees, but their ammunition again failed them, and they were obliged to retreat, and eventually to disperse. The Houssa force of about 200 men rendered good service. On the 21st of April, the Ashantees were within a few miles of Cape Coast Castle. I believe a confederation of the tribes, under the direction and sanction of the British Government, would be the most beneficial on the whole. The late confederation was arranged without the knowledge of the protecting powers at Wankassin, Kings Edoo and Anfoo Oloo being joint King-Presidents.

Cause of the War.—The King of Ashantee states, that being the grandson of "Ossaia Tutu," he owns Elminas to be his relatives, and consequently the Fort of Elmina with its dependencies are his. He could not understand Mr. Hennessy's message, the Administrator-in-Chief sending Mr. Plange a Dutchman, to tell him that he had taken possession of them for Quakee Fram, king of Denkera, and giving him notice that in four months' time he would come and take power from him.

The King says he has been made angry by this, and it was this which led to his sending his great captains and forces to bring the King of Denkera to Coomassie, who dares to take his Elmina Fort.

The King also claims the Assins and Akims who he says are his slaves, and who have united with Denkera to take power from him, and that nothing will appease his anger, unless they and Elmina are given up to him.

Having given a short outline of the country and of the several invasions of the Ashantees, I come to the object for which I have brought this subject before the Institution, namely, how such invasions are to be prevented and resisted in future. It appears to me that, by proper organization and combination of the tribes under our protection, there would be no real difficulty in the matter; but, before I go further I will venture to state that, if in the beginning of last December, when it was first known that the Ashantees were collecting a large force on the frontier, a similar movement on our side had been made, with proper arrangements for a good supply of ammunition and a force of Houssas collected and raised ready to advance if required, the invasion would probably have been checked at once. Now to be prepared to resist invasion, it appears to me the following measures should be adopted:—1st. Get a good military map of the country, or at any rate of that part of the frontier where invasion is likely to take place, and near the great roads from Coomassie to the coast. Have a strong earthwork, or stockade, or entrenched camp in proper position near the frontier and commanding the roads. Let a regular plan of resistance be laid down and explained to all the tribes, particularly on the frontier, such as this:—When they first hear that the Ashantees are mustering in force on the border, the tribe nearest the point should prepare and send immediate notice to Cape Coast (possibly a line of telegraph might be laid; it is only 80 miles), and nearest tribes on each side should join them. A second stronghold should be made, say about half way in front of Yancomassie or Mansue, whichever would be the best position, where a good reserve should be stationed with plenty of spare ammunition (I am supposing hostilities had commenced). The number of fighting men in each tribe should be ascertained from time to time; the position of each tribe in the line should be clearly laid down, and in case of a retreat, where they have to fall back to, which would be an earthwork or stockade, which would give them shelter and enable them to rally. A few native and one or two European instructors should be attached to each tribe, all having the same instructions from Cape Coast. The women would probably carry all stores and provisions; they can carry great weights on their heads (see account of war in 1824, by Major Ricketts). There are no beasts of burden in the country, nor any wheeled carriages. The tribes should be instructed that, when in position or otherwise, they should always have proper outposts and patrols to the front, so as to prevent surprise; they should also organize spies or scouts. The want of this has been the cause of serious disasters.

It has been suggested that we ought to have a diplomatic agent at the Ashantee capital, Coomasie, but this I believe the (our) Govern-

ment object to (see Parliamentary papers); perhaps they are right, but at any rate we ought to have a trustworthy agent as near the frontier as possible, so as to insure the earliest information. Proper arrangements should be made for a supply of water; tube-pumps would be useful, as they can be taken to pieces and easily carried; the force should have mitrailleuses or Gatlings (I believe this is by far the best description of weapon for the country, and I am supported in this opinion by all Officers to whom I have spoken on the subject), small field guns, and rockets, a good supply of trenching tools, such as the natives can use, should always be kept in store at the Cape Castle. I think it an important point that, when we are in sufficient force to check the Ashantees in front, the spare tribes should always attack them on the flank and rear. This appears to me to be a question of considerable importance, for the enemy can only advance along the roads in single file, so that 40,000 men would form a line 20 miles long, which would be open to attack, the whole of that distance, by small bodies of men. It is only when they are taking a position, that they clear the jungle so as to enable them to present a large front.

The next point is, what forces should we have always ready on the spot? I believe the Houssa force is the best; they are a Mahometan race, from the up country near Lagos, and are known to fight well under British Officers, and can be had in any number, at least, for our wants; they are powerful men, not affected by the climate, and cost about one-half of what any other troops would cost.* Sending European troops to operate in that country appears to me out of the question, and even the West India troops require to be acclimatized; all this is well known from our experience in former wars. There would be no difficulty in getting European Officers to volunteer for the service by giving them adequate pay and promotion. The objections to British troops are, first, that they cannot stand the climate; second, the length of time before they can be brought from England; and thirdly, the great expense incurred.

The various castles could be held by a few regular troops, and in an emergency, by men landed from the ships. In most cases the forts can in some measure be protected by the long range guns from the ships. Military Officers who have been in the New Zealand or Cape wars, would be most valuable. There should be a large number of militia and volunteers. We are accustomed to organize or fight with savages in all parts of the world, and there can be no reason why we cannot manage and get the better of tribes on the Gold Coast. It is clear that some decided plan of defence must now be adopted; of course it will cost money, but nothing can be done without that, and I believe the protectorate would easily pay the interest on the necessary outlay; and when peace and security were established, they would have no difficulty in paying the capital.

This subject would have been more properly and efficiently brought before you by a military officer. I do not put this forward in any way as a matured plan, but only to hear the opinion of competent military

* Their pay is thirty shillings a month inclusive, but when in the field they have a ration free, or threepence a day in lieu of it.

and naval men, many of whom have served against savages both ashore and afloat in various parts of the world. These little coast wars are generally carried on by both forces combined; I myself have been employed co-operating with the Army on the north coast of Spain, in India, and in China.

I believe there should be about a thousand Houssas, and a similar number of Militia and Volunteers, along the coast, between Sierra Leone and Lagos, ready to be collected on any one point when required, and I am under the impression that if such a force were collected, and the Cape Coast men properly organised at the present moment (the rainy season), that they would be able easily to drive back the Ashantees when the season for operations commenced.

Latest accounts:—

Important Message from the Camp Cape Coast, 16th May, 1873.

Chibboo, King of Assin, Quabinah Effah, King of Akim, and Aquasi Kaye, King of Denkera, send Prince Coffee Masu to His Excellency Colonel Harley with the following message:—

"They acknowledge with gratitude that your Excellency has done a "great deal for them in this Ashantee invasion, but they would further "implore your Excellency to compel the Cape Coast people and other "Fantees to go to the camp to assist them in driving their common "enemy out of the protectorate.

"If any of the tribes have offended your Excellency they humbly "beg that you will not, on that account, allow them to be taken by the "Ashantees.

"They beg that your Excellency will divide the *Ahbrim* people into "two divisions, and send one to the camp.

"They beg your Excellency to do all in your power to force an "engagement with the Ashantees *at once*, or they will take possession "of Afootoo, which is close to Denkera.

"At present the great bulk of the Ashantee Army have moved on "to two places called *Secebu* and *Assantee*, near to Denkera, on Mon-"day last the 12th instant. They beg that your Excellency will write "to the Accras to come and assist them.

"They beg for more ammunition, and at least 70 muskets.

"The Kings would especially beg your Excellency to compel the "Cape Coast people to go to the camp at once, as they feel sure they "won't move unless they are forced to do so.

"The Denkera people by their King beg your Excellency to let them "have a loan of fifty Benders of gold to assist them in this war, and as soon as it is over, the King will return it.

"His
"Coffee × Masu
"mark.
"Special messenger, from the
"Kings of Assin, Akim,
"and Denkera."

Dunquah, the Capital of Denkera, Besieged by the whole Ashantee Army.

From accounts received late on Sunday night, it appears that the Ashantees have almost removed from Dunquah, their old camp, and concentrated their forces in the bush about five miles to the south of Dunquah.

The greatest fears are entertained that King Aquasie Kaye with his troops will be compelled to retreat, and leave his beautiful fertile country in the hands of the enemy.

Not a single Cape Coast man or Fantee has made the least attempt to go and assist this unfortunate Prince, although for the last two months he and his brave people have been assisting the Fantees, when Yancoomassie, Dunquah, and other villages were attacked by the Ashantees.

The King of Dunquah has sent to inform His Excellency that he cannot hold out much longer against the whole Ashantee Army, and must of necessity retire with the whole population of Dunquah to Cape Coast for protection, unless he can obtain similar aid to that he and his people rendered to the other Fantee tribes for the last two months or more.

Captain E. Rogers, Staff Officer of Pensioners, Longford: I was present when Captain Brackenbury delivered here a very effective lecture "On the Tactics of the Three Arms, &c.," and I was surprised that neither he, nor any of the speakers, referred to the part that mitrailleuses are destined to play in future actions, as most countries in Europe have adopted some modification of that weapon. Russia, in particular, has organised fifty batteries, or 400 Gatling guns, and I believe they have been used in the Khivan expedition. America, too, has brought into use fifty small camel-guns for service against the Indians in the Western States. Surely, then, no scheme of tactics can possibly ignore their existence. But Captain Brackenbury confined himself to civilized contests, so to speak, and therefore the exceptional circumstances referred to in Lord Lauderdale's exhaustive paper were not contemplated by him. After very considerable study of this subject, I venture to assert that there is no gun so admirably and essentially adapted for the purposes of either attack or defence in savage warfare, as the Gatling. It is handy, light, and effective; it does the work of many men, without being subject to the endemics of pestilential Africa, and it possesses an inestimable quality in the fact that it produces an unquestionable moral effect on the strongest nerves. The Prussians who, on all other occasions never failed, did not like to face the Gatling gun, or man-mower as they called it. In fact, so thoroughly convinced am I of the effectiveness of this gun that, when the first news of any serious danger to our settlement at Cape Coast arrived, I volunteered to go there in charge of a battery of Gatlings. The Government did not accede to my proposition. Since then I have had a letter from my friend the Administrator-in-Chief, in which he says, "How I wish you were here with me in command of a battery of Gatlings." With regard to the defence of the Protectorate, I would humbly suggest, as the most feasible means of protecting our settlements in the future, to re-embody the 3rd West India Regiment; the present two West India regiments being insufficient to carry out the duties in places so far apart as the stations on the West Coast of Africa, and in the West Indies. The Houssas are very well in themselves, and Colonel Harley speaks of them in the highest terms as dashing fellows and good soldiers, armed as they are with the Snider; but I venture

Note.—The paragraphs headed "Cause of the War," and "Latest Accounts," are taken from the *West African Herald*, Cape Coast, 17th May, 1873.

to question the expediency of entrusting our interests to any one tribe, for they will inevitably become arrogant and self-sufficient, and will probably end in a mutiny, as befell a similar policy in the case of the Gold Coast Artillery—a local corps. Of course, the Houssa element is very desirable, but I would not employ it exclusively. It may be said that there will be some difficulty in keeping up a staff of eligible officers to properly organise the force on the spot, for it is a very delicate and difficult duty to organise these tribes, and the Officers so employed must be Europeans. That some of us are able to go through service on the coast, I may mention that I have had 14 years in the West Indies, and that I served a year and a half as Garrison Adjutant at Gambia, and my friend beside me, Colonel Ireland, has 33 years' service, of which 5 were passed on the coast of Africa; we are no bad specimens of the effect of climate! It is owing to Colonel Harley's judicious employment of Lieutenant Hopkins in command of the Houssas that the successes hitherto gained may be chiefly ascribed, for this is the first occasion on which the Fantees met and successfully withstood their inveterate foes, the Ashantees. The only reliable system of continued resistance, is to bring the Chiefs to an united and resolute line of policy, and so far Colonel Harley has certainly managed to do so, as was borne testimony to by Mr. Knatchbull-Hugessen in the House; but you must, in addition, have a nucleus, a reserve of regulars, to fall back upon. The tribes should be merely regarded as outlying pickets to the main body on the coast, which, though inferior in numerical strength, should be excellent in kind, and should be supplemented by Gatling guns to make up for disparity of numbers, a few—say four—large calibre* guns should be supplied for fort-defence, and a mixed battery of ordinary ·45 Gatling and camel-guns (which latter only weigh 125 pounds) for other purposes. Small guns would be invaluable in a country which you have heard described as destitute of means of locomotion, and with no beasts of burden of any kind. It is an error to suppose that Gatlings are so delicate and complicated. The locks certainly are marvels of ingenuity, but so is the lock of any ordinary rifle. Naturally our taxpayers are anxious to see the cost of Imperial assistance lessened instead of increased; but if we retain these Protectorates we must abide by the consequence, and be prepared to sacrifice our prejudices to the necessity of the case. And when all is done that can be, what remains? Our dealings with the West Coast of Africa have more or less partaken of a sentimental character, while the few that profit by our possessions there, stimulate and foster this tendency. It seems as if England's policy were at the whim and pleasure of an interested minority. Speakers both in and out of Parliament should take up this question and deal with on its merits. Let the press open its mouth and discuss the bearings of our relations on the coast, and I cannot doubt the conclusions that will be arrived at. I conclude my remarks with this sentiment: "Ireland may not be for the "Irish; but for mercy's sake let Africa be for the Africans!"

Mr. SWANZY: I think I can show you that our influence in Africa is not altogether that of money, but in fact that we, on the contrary, are striving to do some good. I appear here as the representative of the Fantee tribes, because I have been for many years connected with that part of the world; my brother fought and died against the Ashantees, my uncle defended the fort of Cinnamaboe, with 32 men, against the whole Ashantee army, and therefore I have a right to speak. I have been resident there six years, and I have, in fact, by far the largest trade in that part of the world. Let me first account to you for the disorganised state of the Fantee tribes. At the termination of the Macarthy war, and of the battles that followed, Mr. Maclean was sent out as President, under the direction of a committee of merchants, who managed the affairs of the West Coast of Africa in London. He went out, and by his personal influence and tact, with the assistance of £4,000 a year, he managed to extend British influence in every direction. He completely put a stop to the slave trade in that part of the world, and he extended British commerce and civilisation in every direction. That was done without any definite law at all, without any definite granted power; he simply used the tact which God had given

* The gun referred to is the 1-inch ten-barrel Gatling, from which 3,000 missiles can be discharged per minute when using canister cartridge.

him, and nothing more. I myself commanded two little forts on the Coast under him, and the only means I used at that time was to send my cap or my stick to any man guilty of any crime, and he came down and I punished him, or did what was proper in the case. Therefore much was left to ourselves, and in that way I put a stop to accusations of witchcraft and many other evils which had been prevalent on the Coast, and which were a great bar to anything like commerce and civilisation. In 1830 Mr. Maclean formed a treaty with the native tribes and the King of Ashantee, under which the whole of the tribes as far as the Prah were, so to speak, under the protectorate of the British flag; but they then understood, as they do now, that they were to protect themselves. They were ready to protect themselves, and Governors were sent out, military men. I do not wish to depreciate military men as Governors; in many instances they make the most able men. Unfortunately the climate is not healthy, and therefore Governors have not been able to remain long, and, so to speak, to associate themselves with the interests of the natives at all. They absorbed all the power: they took away from the native Chiefs the jurisdiction which they possessed under Maclean; because, in my time, all the Kings of the different tribes had judicial power, levied fines, and had other means of raising a revenue: but when the Governors of the Gold Coast thought proper to absorb all that power, the native Chiefs no longer had the means of raising revenue, and became like so many private individuals, without a sixpence in their pockets. That was the position in which they were when the King of Ashantee, in January 1873, crossed the Prah and came down upon them. They literally have not means enough to buy a keg of powder to defend themselves. The only great victory we have obtained over the King of Ashantee was principally fought by merchants at the head of their people, and of the different tribes, men whose names would not be known in this room; they fought their own battles, and so they would now if they were allowed, but no, it is not allowed. I went out in 1853 myself, sent out by Sir Stephen Hill, and took charge of a force. We had no fighting, fortunately, for I am not a fighting man. But what must be the position of men in this state? They have no means of fighting, no organisation whatever; the power of the Chiefs is no longer acknowledged by the people, and the Government would not allow them to take any part. The moment war breaks out, the Governor sits down in the Castle and says—"Gentlemen, I am ordered by Her Majesty's "Government not to assist you in the slightest way." After a great deal of intercession on the part of the natives and merchants, he serves them out not 150 barrels of powder at one time, but, by dribblets, 10, 15, 20 barrels of powder at a time. Why, I have nearly given out as much myself on my own private account. It is a miserable thing, a case of £450 at the very outside. Her Majesty's Government say it was necessary that Colonel Harley should retain sufficient ammunition in the forts to defend them. Why, 32 men defended a fort, in 1807, against the whole Ashantee body. They cannot take an English fort there under any circumstances. Moreover, there are vessels of the Fleet lying stationed all along the coast who would blow them to atoms in no time. As far as ammunition is concerned and the necessity of saving it, there were plenty of ships full of gunpowder there, had His Excellency chosen to buy it. That has been the great mistake. Colonel Harley has not backed up the men sufficiently. Lieutenant Hopkins and three or four Englishmen only, did everything; it is to them that is owing at the present moment the safety of Cape Coast Castle,—to Dr. Rowe and Dr. McKellah, and two Officers of the Houssa police. Now, they have plenty of force; but what has happened in the mean time? The whole country is devastated in all directions, and thousands of poor creatures have been dragged away to slavery or to butchery in the interior. A friend of mine at Bristol, Mr. King, a well known merchant said to me, "I hate to see Her Majesty's flag flying on the coast. Give "me a native chief and I can trade, I know what I am doing; but give me Her "Majesty's flag and I do not know what I am doing." The revenue of that part of the world is not less than £40,000 to £50,000, and that might be raised to £100,000 which would be ample not only to maintain the safety of the settlements, but to spread their influence into the interior. I do feel deeply on this point, and I am much obliged to your Lordship for speaking on this matter. Your Lordship made use of the word "defection" on the part of the natives. Your Lordship is quite

right, there are three great tribes who themselves are able to cope with Ashantee, if they are united, the Dunkras, the Akims, and the Assins, who were formerly under the Ashantee dominion; any one of these three great tribes could cope with the King of Ashantee. It is not easy to fight a large body of men in a country like that; a small body of men is amply sufficient. The fact is, it was the total want of organization on the part of the natives that led to this disaster. It is the taking away the power they formerly possessed, and then, when the crisis comes, doing nothing to assist them, that has been the cause of it all. I took the liberty of speaking to the gentlemen at the Colonial Office, and suggested the necessity of sending out provisions; because, it is very clear, that famine will ensue. April is the month for planting, and, owing to the disturbances this year, a large portion of the country will not be cultivated. The Government have since done very well; in fact, ever since you Lordship's observations in the House of Lords, and since they have ascertained what has taken place and the reality of this invasion, they have done all they possibly could, to mend matters. In the meantime they were deceived. Colonel Harley estimated the number of the Ashantees at something like 4,000. Mr. Pope Hennessey did the same. He thought it was a mere raid, and he told me also it is customary for the King of Ashantee to break his staff as a declaration of war; and then the Ambassador is sent back and war commences. In this case he had the advantage of surprise; and our own people are not allowed the advantage of surprise. I must thank your Lordship before I sit down for the interest you take in this matter. I have myself contributed something towards scientific discovery in Africa. I take more interest in Africa than that of the mere question of trading. Every proper-minded merchant does so; he does not think only of pounds, shillings, and pence. You, gentlemen, do not, I know, in your profession; and why should you accuse us of anything like that? It is perfectly true that, in old times, when the Slave Trade was prevalent there, we had the strongest sympathies of the British public. That time has passed away, and we are now left to ourselves and are told we must provide for ourselves. We are thankful to be allowed to do so. The cause of the last Ashantee War has been mentioned. In addition to Elmina, among other things the King of Ashantee wishes to get back these tribes, the Dunkras, Akims, and the Assins to his power, for they formed part of the Ashantee tribes. I think the estimate of your Lordship is right—that they number something like 40,000.

Major KNOLLYS, Garrison Instructor, Home District: Before commencing, I must apologise for presuming to take up your time. I have never been on the coast myself, and have no personal experience; but ever since this Ashantee war has begun, I have followed its course with the greatest interest, and have had further the advantage of reading a vast number of letters from the coast, and of personal interviews with a great many people of considerable experience. It has always struck me as a very singular circumstance that we take so little notice in England, of the Coast of Africa. The aggregate of imports and exports, according to the last returns, being about two and-a-half millions, or equal to that of Jamaica. I have every reason to think, from the different returns I have seen, and the opinions I have read, that that is capable of being enormously extended. My own opinion is, that we have only just tapped the surface of the outside of Africa, and that it is capable of a development which will surprise even those who are best acquainted with the subject. As to the cause of the war, I understood in addition to the money paid by the Dutch to the Ashantees for Elmina, under whatever form it was—whether a complimentary payment, or whether they chose to interpret it as a tribute—that there was another reason, which was, that the Dutch used to pay the King of Ashantee so much per head for slaves, whom they employed as troops in their other colonies; and by that being put an end to, the King of Ashantee lost a very considerable amount of revenue. With reference to the Protectorate, I must say I think we have behaved in a most cruel way to the Fantees. We have treated them just as if we had tied their hands, put them in front of a powerful foe, and then said, "You must defend yourselves." There had been, originally, a confederation; and, two years ago, the Fantees endeavoured to revive it. They went rather far before applying to the Administrator, for they had actually appointed an Officer, and drawn up a Constitution. The authorities were indignant that matters had gone so far, without their leave being

asked; and they did not encourage the movement. The recommendation of the Committee was that they should be encouraged to defend themselves as far as possible. In spite of that, as soon as ever they took their first step towards it, merely on account of a breach of etiquette, they were immediately sat upon by the Administrator, and five of them committed to prison on a charge of high treason. His acts were said to be repudiated by the Colonial Office and by the Governor-in-Chief afterwards; but they were repudiated in a very mild way. The tribes were put off from time to time. The last scheme they submitted was six months without receiving any attention; and then came the Ashantee War. It seems to me that our prestige and honour has been very seriously compromised. One of the great complaints of the merchants—native and European—on the coast in the different stations in the protected territory is, that they are not given to understand how far the ægis of the British protection extends. One Governor interprets it within shot of the guns of the different ports, and that is all that he will undertake to defend. Another extends it for two or three miles. But while there is this inconsistency with regard to protection, there is none whatever with regard to taxation. I understand that while they are not at all ready to defend the commercial interests of merchants at a distance, they take uncommonly good care to collect their revenue. There was one case that I read in the *Manchester Courier* the other day. A gentleman said there was a settlement on the Volta where a tax-collector came round to collect revenue duties on the imports; and there was a tribe on the other side of the river whom we had, in vain, endeavoured to bring under our rule, and who refused to be taxed. They stopped all commerce in the river, and attacked and burned the station, destroying a large amount of property belonging to native and European merchants. Application was made to the Administrator for redress; but he refused to give it. The merchants said, "we pay taxes and are entitled to pro-"tection." "No," he said, "Her Majesty's Government will not undertake to "defend those people who are trading at a great distance, and if they continue to "trade at that distance, they must do so at their own risk." Upon which, they put the question to the Administrator as to what was considered an out-of-the-way place, and how far the protection of the British Government would extend. The answer he gave was, that was a question to be asked him by superiors, and not by individuals. That caused a great deal of indignation on the part of everybody on the Coast—both Fantees and Europeans, and it was said that it was ridiculous to talk about it being a protected State, because it was not we who protected the Fantees, but the Fantees who protected us. And if it had not been for the Fantees the other day, the Administrator would have been shut up in Cape Coast Castle. With reference to the method of defending this district, I have understood from reports of different Officers on the Coast, that neither British nor West India regiments can be employed with advantage in the interior—that their health will not stand it; and I am told that the only force to rely upon are the Houssas, which already exist. They were started by Captain Glover, the late Governor of Lagos, and numbered 350 men, 300 being armed with Sniders, and the remainder trained to work artillery. They are excessively well disciplined and well-trained men, and have already done good service in these countries. In the first action there was a body of 120, some few miles in rear of the Fantee forces. They were restrained by the instructions of the Administrator from giving any but moral support; but that moral support was not of much use, and the Fantees had to run away. On the second occasion they did uncommonly good service, and lost about 16 men out of the 120, killed and wounded. The danger alluded to of risking all our strength and putting all out trust in one tribe is, I think, a little overrated. The circumstances are not quite the same as in India, nor with regard to the Gold Coast Artillery Corps alluded to, for the Houssas would be serving out of their own district, and therefore you might rely upon them. They have never given any sign of insubordination; in fact, ever since their formation they have given their superiors the very greatest satisfaction. Captain Glover was very anxious to increase this force, and, had he been allowed to do so, there would have been a very powerful body of men under their commandant, who was an officer in the British Army, and served with distinction in the Siege of Lucknow, Mr. Goldsworthy. If he had been able to bring some 500 of these men to meet the Ashantees on their first invasion, I have no doubt the issue of the first

battle would have been very different. With regard to the estimate of numbers; the numbers have been estimated very largely indeed; and I believe that is explained by the fact that for every fighting man in the Ashantee force, there is a camp follower; therefore you may take half the number of men given as about the fighting force. The total number being given at 80,000, the fighting force would be 40,000. With reference to the future defence of the country, there is this objection to stockades, that if the tribes had to retire and to take refuge in them, they would be obliged to bring their women and children with them; therefore, I should imagine, instead of erecting these stockades outside villages, it would be the best thing to fortify the villages themselves. This, however, is only a matter of detail; the principle is exactly the same. The main point seems to me to be that we should assume the offensive; the Ashantees have never yet been thoroughly threshed; indeed they have always had sufficient reason to think it was quite doubtful whether they licked us, or we them. I cannot help thinking if we were to make up our minds to finish the business and go into the Ashantee country, it would save us a very large amount of money in the long run, and no doubt would largely increase our prestige on the Coast, and render the danger of future wars very trifling.

Commander VERNEY, R.N.: Just three years ago I was about to embark for the West Coast of Africa, and on landing in England this morning, after an absence of three years, I saw at the Admiralty a notice of Lord Lauderdale's lecture. The enjoyment of two years in the Mediterranean has not effaced from my mind the miseries of the months on the West Coast of Africa; and since I have been there, a thought has often arisen in my mind as to what extent it is the duty of Englishmen to be employed on that coast at all? If there is any question of duty, English Officers are ready to go at any expenditure of life and any amount of suffering. But I have failed to see where there is any call of duty to Englishmen from the West Coast of Africa. It seems to me, before we consider the subject of how one is to protect such a great extent of country, the question should first arise whether it is our duty to do so at all. Lord Lauderdale drew an analogy between our reducing our forces in a colony and reducing our forces in a Protectorate; it seems to me there is no analogy at all there. We have a duty to our Colonies, but what duty have we on the West Coast of Africa? What duty have we to protect that large extent of country? Who wants us to protect it? The natives do not want us to protect it. The merchants do not want us to protect them. The gentleman who spoke just now (Mr. Swanzy) told us he does not want our protection, and that they can get on better without it. What is the nature of the protection we have afforded? We have afforded no protection whatever to these people. This very war goes to prove the case that we are quite unable to protect them. Then, what have those who have served on that coast suffered? How have people returned from the coast? Utterly broken in health, utterly useless for their profession hereafter, merely through service on that desolate and abominable coast. In some of our colonies, for instance in British Columbia, there are parts of the country where the merchants are told that, if they chose to go and trade, they shall receive British protection, but if they chose to go to other places they must protect themselves. There you have either the one thing or the other. Either the British flag is there and is able to defend itself, or else you are told you must defend yourselves if you want to go and trade in the wilder parts. Why cannot the same thing be done on the West Coast of Africa? It seems to me it would be perfectly feasible that there should be certain parts of the Coast, such as Cape Coast Castle, where British law and justice should reign, and that if the merchants choose to go and trade in other parts, they must do so at their own risk. How is it possible for us to protect the whole of that great tract of country because, practically, our protectorate goes up beyond Fernando Po. (Lord LAUDERDALE: Our protectorate merely extends between the two rivers Volta and Assince.) But the red line on the map extends into the Bight of Benin; it extends up to Lagos, and there is a large extent of country which I venture to say it is quite impossible for us to protect. No gentleman has yet suggested that view of the case, and I shall be glad to hear, if anyone will condescend to do so, how it strikes any gentleman present that it is our duty to extend the light and help that we at present afford on that coast. The very day that we left the coast in the "Growler" there came off a poisonous wind from the shore, the worst that I have

ever experienced, and two days afterwards quite a third of the ship's company were laid up with fever. By the mails that we received shortly afterwards, we heard of several deaths that had occurred from this poisonous wind that came off on the very day we left that pestilential coast. I should be very sorry to think that any Officer was sent out to organize troops there, or to carry on operations in the interior, unless it was first made perfectly clear that it was our duty to maintain our protectorate over so large a portion of the coast.

Captain BEAMISH, R.N.: I came here quite unprepared with any observations on the subject. We cannot but thank Lord Lauderdale for bringing this subject—so very much connected with British prestige—not only before Parliament, but also before those who are able to speak upon it. I do not agree with the gallant Officer behind me (Captain Verney) as to our protectorate, particularly from the point of view in which he regards it. I think, however, that what is called our protectorate there might better be called a confederation. I think we have taken the heart out of these fine tribes in that part of the world. We have not allowed them to have very much to say for themselves, and then, when they are in the lurch, we are not able to help them. I do not think we can defend that part of the world by any means, and in that way I agree with Captain Verney, and I think it preposterous that we should attempt to do so with Europeans. A gentleman on my left, who spoke about the Houssas, spoke extremely to the point. Captain Glover, who has lately returned from that part of the world,—one of the most valuable men who has worked out there for a large number of years, certainly one of the most energetic and far-seeing,—I won't say the inventor of Lagos, and certainly the inventor of the Houssas, got rather snubbed for a good many things connected with these Houssas, but he has carried out his views, and the Houssas have been found to be invaluable. I do not see any danger that can arise from their employment. They are Mahommedans, and are therefore more civilized than the natives of the coast, and are very much tied together in consequence. I think they might be made to form a part of, if not *the* regular Army, of that protectorate or confederation as well as at Lagos. Let us try the experiment, if you please, all along from Cape Palmas to Fernando Po. With regard to having small fortifications, I think perhaps some of the natives near the forts might be taught to fortify their villages; but if we are to do anything in the way of fortification for protecting our coast, we should have them within a circuit of a very few miles, and, if necessary, it might be done with small earthworks. I think, perhaps, the Gatling gun would be too difficult for the natives to work; but I am quite confident the Houssas and others might be very well taught to work small mountain-guns or camel-guns. Our prestige on the coast of Africa has gone down extraordinarily. We have put a stop to slavery, and the result is now we are not holding up our heads, and judging by what I can read and from what I saw when I was out on the coast some years ago for 3½ years, I feel this about it, that nothing can possibly be more wrong than the uncertain state in which we leave these unhappy natives as to protectorate, confederation, and so forth. I think we should let them understand that we have a very small belt round our sea-ports which we absolutely will defend to the death; but that we will help them with ammunition and occasionally with money, and with military tuition to keep up the confederation I spoke of. And I would go so far as to flatter the great Kings and Chiefs by giving them at least something to say in the assembly or council in the large main towns at the head of the confederation. If these men are left outside in the cold till some one comes and attacks them, and are not allowed to combine together without getting into a scrape for it, the chances are our prestige must go, and before the public know it, we shall have the whole country covered with blood (as it really has been for a long time) and entirely devastated, unhappy children carried into slavery, and nearly all the old people slaughtered. I think what would be a useful thing (and I do not know that such a thing exists on that part of the coast) would be that each protectorate should have provided for it a very small steamer, not necessarily a man-of-war steamer, but one possibly belonging to the colony. It could lie with very great safety off Cape Coast Castle, and it might move about from one part to another for the purpose of carrying supplies, and enabling the Governor to visit the different parts under his protection.

Colonel YONGE, late 1st West India Regiment: When I went out to take the

command of the troops on the West Coast, my command reached from Gambia to Lagos, and then they made me an Administrator-in-Chief. I know Colonel Harley and Captain Glover, and I heard the name of that gentleman long ago —he is bearing a high character in that part of the world—but we are not allowed to assist each other. If they choose to protect the base, it can be done easily enough; but I do not see that any gentleman yet has replied to your Lordship's question—which is the best way of protecting this part of the world? My idea is, if they intend to do it, that they should have a couple of thousand men well officered and well commanded, and who should not be sent out against their will, but should be volunteers, and you will find more than 2,000 men who would be willing to go. They ought to be well paid for it; it is very hard times that men should be serving there and scarcely be able to live. I was utterly astounded when I went back, to discover that it had been proposed that our canteen should be taxed. Are we not only to pay in person but also in purse? I was delighted, however, to find that such a sum of money would be allowed to each Officer as would counteract the attempt made to put a tax on what we had. When Mr. Monsell was the Under Colonial Secretary, I said to him, "Now, Sir, I seek the appointment as "Governor-in-Chief of that place, and if you, having appointed me, were to ask me "to-morrow what I thought about it, I should say, remove us all away, both civil "and military." I know very well how the merchants thrive there. Look at Lagos; look at Benin. I was there; and there they are more prosperous than we are where we have our own force, at Sierra Leone. I asked Mr. Monsell what good it could be to the merchants of England to be charging them on imports and exports to the amount of £50,000 a year. I therefore agree in saying that I do not think we have any business there; but if you intend to protect those States, do it effectually, for it is a great shame that we should mislead these people and pretend to protect them when we do not. I think 2,000 volunteers, well paid, with four of Her Majesty's ships working down the coast, would do the work. These ships might go to the Canaries, to Teneriffe, here and there, even to that beautiful island of Fernando Po, where fellows can go to amuse themselves and recruit. Then you must have good weapons, if you are going to do it at all. When I went to Sierra Leone, the first thing I did was to go to an old friend of mine, then Deputy Adjutant-General. I said, "I am going to Sierra Leone, and I am entitled to have the very best weapons "you can give me." He said, "You are right." I had no occasion to use them, but I showed the natives the effect of them, and it prevented their going to war with the French up the rivers. I was then Administrator-in-Chief, and they came to me and threatened war. I said, "Nonsense, if you are wronged, appeal to the justice "of the Emperor, but don't you go to war with them, or you will be eaten up," and I showed them the effect of these guns. The giving me those guns brought honour to our country, for it so happened that by their use 40 men turned aside something like 500 men in the Orange country. A young gentleman came to me with a letter of introduction, and asked for the guns. He used them successfully on that river, and I am delighted to say he has been promoted from a subaltern to a Captain for his good service—a most unheard of occurrence.

Mr. LAW: I was on the Coast last year, and with reference to the question how we are to attack Ashantee, my idea is that we should go up the Volta. I have been up the Volta with the late Captain-Governor Administrator Saber. We steamed 120 miles. It has not been thoroughly surveyed. Captain Glover led an expedition in the year 1870, but they had a good 'deal of fighting, and there were 300 or 400 men killed. We can steam up the Volta within 60 miles of Ashantee. It is a beautiful open country, with large plains and immense trees. If we attempt to go up as we did originally in the expeditions of 1862 and 1865, to cross the Prah and go up there, it is next to impossible, because the pathway is so narrow that the men have to go up in single file, and it is next to impossible to take a great force up; but if the Volta is explored I think we can do it. There is only one fort at Cape Coast Castle, Fort William, which is of any use. There is another fort there, but it is of no use whatever; it is a mere outwork. But there are other hills on which forts can easily be placed. At Elmina, there is the best fort that we have on the Coast, and the guns are the best guns; ours at Cape Coast are not to be compared to them; in fact our guns are old and useless, both at Cape Coast

Castle and Fort William. Another error that I noticed, my Lord, is with regard to the rifles supplied to the natives out there. All the natives have been able to purchase the Snider rifle since August, 1870. I have seen them myself sold in the different stores by merchants, with 100 rounds of ammunition, for £3. Major Rose was with me at the time, and remarked it. I said, "I am astonished "at this; what can we do?" I may also say as to the cause of the war, I believe the Dutch have always paid a fief to the King of Ashantee; and not only that, but I believe it is a fact that they have paid so much for every slave. Another thing that has brought on this war is that the King of Ashantee thought he could cope with us, and he had very good reason for thinking so, for his uncle was allowed to overrun our territory in Chopo and to commit unheard of atrocities. He ought to have been put to death the moment we seized him; but no, he was sent out, and allowed to pass free and unmolested. As to the ammunition, I have heard that the ammunition supplied to the Fantees was in great measure bad, and I have every reason to believe it, because I have seen it. Our ammunition that we had there has been there for years, a great deal of it. Hundreds of barrels were more or less damp, and I believe they were supplied with this ammunition.

Rear-Admiral Sir JOHN HAY: Can you inform us what was the draught of the steamer in which you went up the Volta?

Mr. LAW: I went up in the "Nelly;" I think she drew 6 feet.

The Earl of LAUDERDALE: In replying to the remarks which have been made during the discussion, I would say that four men will carry a Gatling gun quite easily, and the carriage can be carried by four more, while the ammunition may be carried by any number behind. I do not see any objection to the West India regiments, only I believe that these Houssas, whom you get on the spot, and who are acclimatised, would be the best. Captain Rogers also referred to a reserve of regulars; does he mean a reserve of the West India regiments? (Captain ROGERS: A reserve of the West India regiment.) Mr. Swanzy spoke of the famine that is certain to ensue. I am quite aware that that is a most serious point. These four tribes are now losing the season for sowing their crops, and they will be starving. There is no doubt that the Government will have to send out provisions. He also remarked that our Government underrate the numbers of the Ashantees, and I believe that to be perfectly correct. I have no doubt you can get up the Volta, but that is the only river, and it is rather a roundabout way. I am quite aware that the ammunition supplied to the Fantees was bad. With reference to Captain Beamish's remark that we could not defend the whole coast, the territory I am alluding to is only that between the Volta and the Assinee, the whole length being 250 miles. It is said that the proper plan of organizing these tribes would be a confederation. A confederation has already been tried, and it is approved of by our Government. The tribes did form a confederation, and laid down rules and constructed their Government, but they had done it without the sanction of the British Government, and the British Government threw it over. Not only that, but they put the leading men in prison. Still, I quite agree that the confederation would be one of the first steps, but it must be a confederation under the sanction of the British Government. I think another gentleman said that he did not agree with me about a protected territory, and that it is very different from a colony. I do not see the great difference between a territory properly protected by the British flag and a British colony. Perhaps he is aware that the Ionian Islands which we held for so many years, were not a British colony, but were nothing more than a protected territory. They had their own Government, a Government formed for them by us; but if any nation attempted to look at the Ionian Islands, while we held them, or attempted to hold up a finger to go that way, why we would have defended it to the last man we had. We laid out thousands of pounds in building fortifications; this was nothing more than a really protected territory; and when we take it upon ourselves to protect any territory, to say that we will protect them, to give the name of the British Government, and to allow our flag to be hoisted, I consider that we are quite as involved in protecting them, as if it was one of our colonies. Colonel Yonge gave us very valuable information. He thinks that the people that are not under our flag are more prosperous than those that are. That is not a question that I enter into. So long as we

have protected territories we are bound to protect them. One of the objections to the confederacy was, that of course you cannot have a Government without taxing the people to pay your Government, and then as we tax them again, these poor unfortunate people would be doubly taxed. If there is any confederation, we must be at the head of it, so that there shall only be one taxation.

The CHAIRMAN: I think I may safely ask the meeting and the Institution to give their best thanks to Lord Lauderdale, for his kindness in coming here. The subject is one of great interest, and Lord Lauderdale has taken it under his protection, and has ventilated it very well. We must also thank those gentlemen who have kindly taken part in this discussion.

Evening Meeting.

Monday, May 12th, 1873.

LIEUT.-GEN. SIR FREDERICK CHAPMAN, K.C.B., R.E., Inspector-General of Fortifications, in the Chair.

NAMES of MEMBERS who joined the Institution between the 22nd April and the 12th May, 1873.

LIFE.

Sawyer, W. H., Lieut. 43rd Regiment.
Harston, C. G., Lieut. late R.M.L.I.

ANNUAL.

Johnson, Cecil F. W., Commr. R.N.
Richardson, J. S., Lieut.-Col. N. S. Wales Local Force
Powell, C. F., Lieut. Bengal Staff Corps
Fenwick, N. E. de B., Lieut. 60th Rifles
Wallace, N. W., Captain 60th Rifles
Beresford, G. D., Major Madras Staff Corps
Crawfurd, H. J., Lieut. Gren. Guards
Shute, Neville H., Col. late 64th Regt.
Fagan, C. S. F., Lieut. R.M.L.I.
Hawes, A. G. S., Lieut. h.-p. R.M.L.I.
Goold, H. H., Major late R.M.L.I.
Craufurd, C. W. F., Lieut. R.N.
Ray, A. E., Major 3rd Middx. Art. Volrs.

FIELD RAILWAYS, AND THEIR GENERAL APPLICATION IN WAR.

By Captain C. E. LUARD, R.E.

SIR FREDERICK CHAPMAN AND GENTLEMEN,

Since Captain Tyler lectured in this Institution ten years ago, I am not aware that the subject of railways has been again introduced, and it seems perhaps rather strange that such should be the case. It therefore is scarcely incumbent on me to offer any apology for endeavouring to condense into an hour's lecture a matter abounding in details, gaining in intricacy every day, and in which our country was the first to take the lead, and to plant its great railway works over the face of the globe.

As nations advance in civilization, it naturally results that their scientific knowledge gradually expands, and this advance in scientific knowledge is, or ought to be, demonstrated as much by the science of war, as in more peaceful pursuits.

Among the many changes science has produced in the art of war, there are probably none greater than those which result from the application of railways to military purposes. So highly indeed is their value considered in the present day in developing strategical combinations, and in furthering schemes which would formerly have been

impracticable, that it has been said with great truth, that whilst the due use of railways do not relieve a military man from the general studies which are indispensable to him, they constitute to an able man an additional arm, and impose on him fresh duties.

The wars in which railways have been more prominently used, are, firstly, the Crimean, concerning which the time at my disposal does not allow of my saying much. The railway from Balaclava up to Sebastopol was only about 5 miles in length, and though looked on at the time as rather a marvel, and introducing quite a new element into war, yet at the present time it would be considered a very unsatisfactory makeshift. It, however, gave a good deal of trouble to make. Commencing at Balaclava it was worked by a locomotive for about 2 miles; at this point the locomotive was detached and the train was worked up an incline of 1 in 15, and about $\frac{1}{3}$ of a mile long, by means of a stationary engine which rose eight waggons at a time; on arriving at the top of this incline, six horses were attached to each pair of waggons and took them up an incline of $\frac{1}{2\frac{1}{3}}$ for about $1\frac{1}{2}$ mile to the Col de Balaclava. From that point, the line was pretty level, but there were two gulleys to be crossed, and these were crossed by the primitive method of detaching each waggon in succession and making it run down one side and run up the other side of the gulley by its own gravity; when there, horses were again used, and so the munitions arrived at Forks Depôt, the terminus of the line.

The line was constructed by English contractors, and was worked by Land Transport Corps, though attempts had previously been made to work it with the Army Works Corps and civilians, an ill-trained, ill-organized, unruly lot whom the Director of Transport was obliged to summarily dispose of, to enable him to get the work done. The work at first comprised the daily transport of about 200 tons of material, but ultimately it amounted during the last bombardment, to about 700 tons a day, to do which, the line was worked day and night for several days with about 1,000 men, of whom 400 were Turks. Having had the advantage of conversing on these points with Major Powell, the Officer who directed the transport at that period, and I believe during the whole life of that railway, I am able to submit these facts to the consideration of the members of this Institution.

The next European war displayed a considerable advance. The French poured troops into Piedmont by railway with great rapidity and regularity so as to conduce very much to their success in the campaign, and on one occasion (Montebello), the allied army was augmented during the progress of a battle with troops brought up by railway. The Austrians did the same at Magenta. But if we were in possession of all the details of the management and application of railways during the Civil War in America, there is more in that great struggle from which we might learn their use, their construction, and their destruction, than even from the last great European wars. I will take the liberty of extracting from Major-General McCullum's Report a few notes which will be generally interesting. From the very commencement of the war, railways were in constant use; the tracks (as they were termed) were laid, destroyed, and re-laid, and bridges were built, destroyed, and

re-built with a celerity which appear almost marvellous. But matters were done on a large scale then. It was not, however, till nearly a year had elapsed, that it became apparent to the Federal leader that the organization of a Construction Corps was of paramount importance. The corps numbered at first about 400 men, and expanded gradually to about 10,000. The design of the corps was to combine a body of skilled workmen in each department of railroad construction and repairs under competent engineers, supplied with abundant materials, tools, mechanical appliances, and transportation. They were formed into divisions, gangs, and squads, in charge respectively of supervisors, foremen, and sub-foremen, furnished with tents and field equipment; and store-houses were established at principal points with an ample stock of tools and materials.

The general charge of the railways for the department of Tenessee, was taken up very vigorously, and the general manager subdivided his department at once under a general superintendent for transportation, and a chief engineer, giving extensive powers to each.

The former department had—

1st. To conduct the transportation, and manage the movement of trains.

2nd. To maintain the roads and structures, and keep in repair the roadways, bridges, &c.

3rd. To maintain the rolling stock, and manage the fitting and repairing shops.

The latter department was organized in six divisions, and mustered at its maximum strength about 5,000 men. To give the corps entire mobility, enable it to move independently, and perform work at the same time at widely different points, each division was made a complete whole in itself and equipped complete, in order that the whole or any part of the same, might be moved at once in any direction when ordered, and by any mode of conveyance, by rail, with teams and waggons, or on foot.

Their organization is given in the Appendix A; each corps mustered 777, all told; giving for the six divisions, as I have said, about 5,000 men.

As an example of rapidity in execution of work, I may mention the Chattahoochee bridge, 780 feet long, and 92 feet high, *which was completed by the Construction Corps in 4½ days.* The Confederates gave the Federal Construction Corps plenty of employment, for in October, 1864, General Hood passing round Sherman's army, fell upon the railroad at Big Shanty and at Resaca, and destroyed 35½ miles of track and 455 lineal feet of bridges; but in *thirteen days*, trains were again running over this line.

On another occasion, 25 miles of track and 230 feet of bridges were reconstructed in 7½ days.

On another occasion, General Wheeler destroyed 25 miles of track between Chattanooga and Knoxville.

During General Hood's occupation of Tennessee, in December, 1865, all the bridges were destroyed; their repair was commenced in January,

1866, and by the middle of February 2,200 feet of bridge was rebuilt, and the line re-opened for traffic. During the succeeding winter, these bridges were many of them swept away by floods—some of them three times—and rebuilt.

It was the opinion of General McCallum that their success was founded mainly on the admirable though somewhat terse orders issued from the Adjutant-General's office, which were as follows:—

Commanding Officers of troops along the United States military railroads will give all facilities to the Officers of the roads and the Quartermasters for unloading cars so as to prevent any delay. On arrival at depôts whether by day or night, the cars will be instantly unloaded, and working parties will always be in readiness for that duty, and sufficient to unload the whole train at once. Commanding Officers will be charged with the guarding the tracks, sidings, wood, water-tanks, &c., within their several commands, and will be held responsible for the result. Any Officer neglecting his duty in this respect shall have his name struck off the roll of the army.

No Officer, whatever may be his rank, will interfere with the running of the cars as directed by the Superintendent of the Road. Any one who so interferes will be dismissed from the service.

Without this order the whole railroad system, which proved an important element in conducting military movements, would have been not only a costly but a ludicrous failure. The fact should be understood that the management of railroads is just as much a distinct profession as is that of the art of war, and should be so regulated.

It requires no apology, for me to quote further from General McCallum, as follows:—The men were continually exposed to great danger from the regular forces of the enemy, guerillas, &c., and owing to the circumstances under which military railroads must be constructed and operated, what are considered the ordinary risks in civil railroads are vastly increased in military lines. Hence the difference between civil and military railroad service is marked and decided.

The hardships, exposure, and peril to which train-men especially were subjected during the movements incident to an actual campaign were much greater than those endured by any other class of civil employés of the Government—equalled only by that of the soldier while engaged in a raid on an enemy's country. It was not unusual for men to be sent out for five or ten days with no sleep but what they could catch on their engines while being loaded or unloaded, with little or no food, while at the same time occupied in a manner which strained every faculty. Their railway organization became at length, *i.e.*, after about three years of war, so good as to enable the Federals to supply General Sherman's army of about 100,000 men (60,000 horses) with supplies from about 860 miles distance, by one line of single track railroad, located almost the entire distance through the country of an active and vindictive enemy.

The attacks on the line in rear of Sherman's army were of such frequent occurrence, and often of so serious a character, that to insure speedy repair it became necessary to station detachments of the con-

struction corps at various points along the road, and also to collect supplies of materials, such as iron rails, chairs, spikes, iron ties, and bridge timber, at points where they would be comparatively safe and easily obtained when required, and construction trains were kept ready loaded with tools and materials at each end of the road to move at a moment's notice. As an instance of their capacities of transport, General Hooker's corps, of 23,000 men complete, was carried from the Rapidan, in Virginia, to Stevenson, in Alabama, a distance of 1,250 miles in seven days.

The greatest number of men employed on railways at any one time	24,964
Length of railway opened and re-opened	642 miles.
Bridges built or rebuilt	26 miles.
Number of engines employed	419
Ditto cars ditto	6,330

The net expenditure was thirty million dollars, but the question then was not how much will it cost? but can this work be done at all at any cost?

Now in this civil war there are many points in connection with the railway management which are worthy of observation. In the first place you will observe that from the very commencement of this war, the Federals began to pay great attention to the subject, but that it was not for some time that they appreciated the paramount importance of carefully organized and disciplined corps. Secondly, the rapidity and facility which, with the assistance of these corps, they were able to maintain their railway system, and place thorough dependence on it; and, thirdly, the large number of men they found requisite to employ on the service.

The next war which showed the value of railways was the so-called seven weeks' war between Prussia and Austria, of which some notes were taken by Major Webber.

It appears that in advancing over the railways which had been in possession of, or had previously belonged to, the Austrians, the Germans employed, as part of the field railway department, a detachment organized as follows:—

It was partly military and partly civil.

The military were—

1 Colonel, 1 Lieutenant of Engineers, and 50 Non-commissioned Officers and men of the Pioneers.

The civilians were—

1 Head railway engineer, 2 Under ditto ditto, 6 Foremen, 2 Machinists, 1 Telegraph official, and 2 Locomotives and 30 waggons and trucks were placed at their disposal for penetrating into the country to be explored.

On the train were carried—

2 trolleys, and 6 light covered carts, viz:—

1 for Colonel Commanding, 1 for Lieutenant of Engineers, 1 for head engineer, 1 for two engineers, and 2 for nine sub-officials.

These carts were intended for use (if it was necessary) to march by road, &c.

The pioneers, who were exclusively carpenters and smiths, were armed and equipped in the usual manner.

This detachment carried 250 yards of permanent-way plant, and some materials for bridging. This section was attached to the 1st Army Corps.

The reconnaissance starts with, and until interrupted, keeps up with the advanced guard, the movement being covered by cavalry scouts on each side of the line.

The greater portion of the train in charge of the department, with one engine in front and another behind, advances slowly, preceded at a distance of about 500 paces by a trolley, carrying one of the Officers, four men to work it, and a bugler. On arriving at any obstruction the trolley signals to the train by bugle, and extra caution is used in advancing towards it. If in presence of the enemy, the scouts give warning to the Officer in the trolley, who returns to the train, and the whole retires. The second engine can be detached to the rear with messages or for fresh supplies.

I cannot wait to discuss this campaign, but the Prussian arrangements worked admirably till the bridge at Lobkowitz was destroyed, which broke the line for eight days.

The conclusions arrived at by Major Webber were very much to the point. Two things, he considers, are very important, viz., the creation of obstructions, and their removal. And the Officer in charge of this must be immediately in communication with the Commander-in-Chief, so as to be made aware of the nature of the proposed operations in order to be prepared for all emergencies.

He must also have a thoroughly organized and well trained corps under him.

In the construction of bridges, the Prussians had ample supplies of timber for repairing bridges, and this might generally be anticipated.

In this war, the Prussian field railway department was employed in the restoration of the lines, the working of them being immediately taken up by the railway officials, the Austrian staff of under employés remaining in their places, and the traffic of each station managed by an Officer of the Quartermaster-General's department.

There were three departments engaged, but they were all under military discipline. If the state officials and Austrians had not been available, the lines could not have been worked without a special staff; but armies invading a foreign country might meet with none of these facilities.

We now arrive at our own last little war, that of the expedition to Abyssinia; and I will take the liberty of abstracting the following observations from Lieutenant Willans' able report, on the subject of the railway there constructed:—

It does not appear to have been anticipated to do more in the first instance than to lay a short tramway between the landing-place, wherever it might be, and the depôts a short distance from the shore, but as soon as it became known that the Sooroo Pass would be the main route to the Abyssinian highlands, it was decided to construct a railway from Zoolah to the foot of that Pass, and in November orders were sent to Bombay for the necessary plant. It arrived in driblets, together with the platelayers, previous to which the work of grading had been zealously carried on by the troops, and small portions had been laid by them also. There was a good deal of difficulty encountered by those who had to make this line, as it had to be made through a timberless country, and the plant which arrived from Bombay was not always packed with discrimination; for instance, rails would come in one ship, and spikes in another, and sleepers in another, one of which ships would perhaps go astray, or be unable to be discharged at the same time as the others. The artisans of the 23rd Punjaub Pioneer Regiment had actually to make augurs to bore the holes in the sleepers."

In the middle of January they were able to form two trains, which for some time had to do all the work of the army as far as the line was completed, and so great were the demands on the two landing-piers at first, that it was with the greatest difficulty the railway plant could be unloaded; at the same time organized gangs of coolies arrived, but the Chinese were the only men who were really useful, the natives not being physically strong enough for the severe work required.

By the end of January, about 4 miles of line were completed, and the entire line of 11 miles, with a mile of sidings up to the Koomaylee terminus, was completed by about the end of April.

The rolling stock consisted of four engines and sixty waggons, which, though severely taxed, did the work throughout; and from the middle of May to the middle of June, of conveying from Koomaylee to Zoolah the whole of the troops, stores, baggage, and itself. The rolling stock was of inferior order, mostly old contractors' stock, requiring an immense deal of repairs and constant anxiety. The best locomotive could only draw fifteen small loaded trucks (perhaps 40 tons) up an incline of 1 in 60.

The waggons or trucks were springless trolleys, with cast iron axle bearings, and no grease-boxes, and the driving sand caused them to be continually worn out; of the sixty trucks about twenty-four were always under repair or unfit; the rails which were sent were of no less than five different patterns, and when they arrived it was found that in some cases the holes in the rail-ends and in the fish-plates were not placed at uniform distances, so that they could not be properly bolted together; they varied from 30 lbs. to 65 lbs. a yard, but the lighter rails were only of use for sidings. It was the opinion that the smooth travelling on the heavier rails, and the ease with which it was kept in repair compensated for the increased trouble and delay in laying. There were several bridges, the widest of which was about 72 feet.

The ruling gradient on this line was 1 in 60, and the maximum curve had a radius of 870 feet; the earthworks were comparatively slight; the gauge was the Indian 5′.6″ gauge.

The 12 miles took about four months to make, and this may seem longer than ought to have been the case. I confess though that the case appears to be, that with the difficulties which had to be encountered, it is remarkable that it was made at all, and when made, that it did its work effectually.

The process of laying the lines after the grading had been completed was as follows:—

The plate-layers were divided into 4 parties (See Appendix B.), and totalled about 150 men, of whom 43 were skilled, with parties of labourers, averaging 120 men, for carrying plant and unloading trains; with the light single-flanged rail, the rate of progress, when no delay occurred, was about 400 yards a-day, and with the heavy double-flanged ditto, with chairs, it was about 250 yards per day of ten working hours.

The civil establishment for working the line consisted of 1 storekeeper, 4 engine-drivers, 5 firemen, 3 station masters, 6 guards, 5 clerks, 3 railway telegraph signal men, and 12 pointsmen and signal men, and at the repairing shop there were—

1 locomotive foreman.
6 fitters.
3 boiler makers,

And about 50 native mechanics.

There were some difficulties about repairs. A very complete fitting shop was sent, but it was never put up, for although probably very carefully packed at Bombay, these arrangements were altogether neutralized by the vessel going ashore in the Red Sea, and her cargo having to be transferred to another ship, when it was distributed anyhow.

The remarks about the civilian staff are especially valuable, and I quote them in full:—

"The civil establishment picked up in Bombay at a short notice, and "without increased rate of pay being offered to them, could scarcely be "expected to give satisfaction, although in some instances we met with "valuable service. Some of the employés were dismissed, and their "places supplied by promoting those who seemed deserving men. We "lost through casualties and dismissal about 25 per cent. of the Euro-"pean civilians, and they were always a source of trouble and anxiety "to us, and Lieutenant Willans is of opinion that in future it would be "advisable to substitute for them, as far as possible, men from the "ranks.

"Intelligent non-commissioned Officers would make good station-"masters, as their most important duty is to obey orders. Guards "would be furnished in the same manner. Pointsmen and signal-men "could easily, if required, be supplied from the ranks. Engine-drivers "and foremen plate-layers were almost the only men whose places could "not be filled from the Army and Navy. Firemen and fitters can be "supplied from the latter, and for some time the duties of locomotive "foreman on the Abyssinian Railway were efficiently performed by "one of the Engineer Officers lent from H.M.S. 'Octavia.' The

" temperature under which the work had to be carried on at the " close of the Expedition seems quite appalling, sometimes up to 180° " Fahrenheit."

War is a difficult game to play, and the construction of this railway in war was, under the circumstances, most difficult. I highly honour, and I think that too much credit can scarcely be given to those who successfully carried out this work, small and insignificant as it may seem beside those in the great European and American wars.

German War.

We have now arrived at the year 1870, in which the struggle took place between the Empires of France and Germany for the possession of the Rhine frontier.

Much as I would wish, I cannot stop to comment on the remarkable events which then took place. Both sides started with considerable experience of the working of railways, and poured their troops and supplies on to their frontiers with all speed. We know that in a fortnight from the date of the order for mobilisation being given, the Germans placed 15 *corps d'armée* complete on the frontier, and did it methodically, so that everybody arrived at the right place at the right time, whereas the French sent everybody labelled *à Berlin*, and much confusion resulted when they arrived at the terminus of the line. The German organization appears to have been more perfect throughout than that of the French, and the results were consequently more successful; of course they had had more recent experience, which is more valuable than all theorizing, and they played throughout with winning cards.

I cannot do better than recommend those interested in the subject to peruse the " lessons " learned by Colonel Jacqmin, from his experience in the working of the railways in this war, reviewing, as he does in his able work, their ministration on both sides.

His conclusions are, that it is necessary to bear pre-eminently in mind two things:—

1st. Unity of command in everything which concerns the employment of railways, whether for the transport of passengers or goods.

2ndly. The association of the military and the technical element, a permanent association acquainted with all the phases of the railway system, so that, before giving an order, one might depend on its being possible to execute the order and that the results would not be as unfortunate as have been described, or which others may have to describe.

Practically, it seems easy to develop this programme by the adoption of the following measures, which form three distinct groups:—*General Measures—Purely Military Measures—Technical Measures.*

General Measures.—To establish, at the Ministry of War, a permanent Military Railway Committee, similiar to those of Artillery and Engineers. The committee to be composed of a General Officer as president, three superior Officers of the Staff, the Artillery, and the Engineers; a superior functionary of the intendance; a superior functionary of the public works department; six directors of the principal railway companies.

The Military Committee would concentrate at Paris all the information relative to French and foreign railways, and their employment in time of war.

Its action would extend over the whole of France, by means of Commissions of Ways and Means, each of which would be composed of an Officer and a representative from the railway companies.

Purely Military Measures.—To revise and simplify the previous regulations for the transport by railway of troops and material.

To take steps to ensure on their journey the provisioning of men and horses.

To instruct all the troops, as a part of their duty, in the best mode of getting in and out of trains, and loading and unloading military *matériel*, whether at the stations or out anywhere along the line. This to be considered, and to be on the same footing as drill. To include, in the duties of cavalry, the defence and attack, at great distances, of the lines of railway, for which they should be provided with a special stock of tools.

To distribute maps freely, and encourage the study of geography and topography.

Technical Measures.—To complete, in a certain number of stations, the means of utilising the platforms and docks, by the construction of ramps.

To include, in the time-table of each company, a certain number of trains arranged in accordance with military requirements, and which could be used on the receipt of a despatch.

To create 10 or 12 military field companies, analogous to those of Germany, whose duty would be to repair the lines or other works destroyed by the enemy.

To connect the arsenals and the military establishments with the general network of railways, especially where such connections do not at present exist.

To construct special works outside the towns, for protecting the tunnels, viaducts, branches, and other important railway works.

Jacqmin's opinion is that the civil railway staff should be associated with the military element, and his views are being at the present time carried out in France. The detail of the composition of the new Railway Committee just appointed, is almost precisely similar to that already quoted from his work, except that there are only two in place of six railway directors. Some very important arrangements have also been quite recently made in France to recruit for this department. The recruits of the French military engineers will be classified in three categories:—the first (two-thirds of the whole contingent for the year) will be incorporated in the active battalions, and will be instructed as sappers, miners, or as soldiers of the engineer train.

The second (one-sixth of the year's contingent) will serve one year only in the active battalions; it will then be distributed among certain of the principal railway companies, in order to learn the working and management of their lines, their construction, and restoration.

The third (one sixth of the contingent) will only serve one year in the active battalions, and will then be transferred to the depôts. These

will carry on operations with torpedoes and dynamite, &c., and be practised generally in the destruction of railways, bridges, &c.

A very similar organization of a military railway department has just been established in Italy.

Besides the constant work entailed on the German railway corps, there was one special work constructed in the neighbourhood of Metz, which merits a more detailed description than usual.

At the commencement of the war, says Rustöw, the Prussian General Staff had assumed that Metz would be able to hold out for a protracted space of time, and that it would probably break the railway communication between their armies and the frontiers of Germany, and they therefore decided to restore this by a field railway, and preparations were made for the same. On the 14th of August, the day of the Battle of Borny, the survey of the ground and the levelling were commenced by the military detachments; on the 16th the construction of the line was begun, and it was finished by the end of September. It was from Remuilly to Pont-a-Mousson, a distance of about 18 miles direct, the total length of the line being 36 kilometers, or say 22 miles, giving an average of about 1,000 yards a day. The number of men employed was about 4,000 a day, composed of two field railway companies (450 men), four fortress pioneer companies (800 men) and about 3,000 miners from the coal districts of Saarbrücken, temporarily out of employ. To assist them was a park of about 250 vehicles, and after a short time the 84 waggons of the pontoon trains of the 7th and 8th *corps d'armées*. The work was carried on at several points at once, and included two bridges over the Seille and the Moselle, and two viaducts. It is reported that the total weights to be transported, amounted to 8,750 tons, presumably of permanent way, or about 400 tons per mile.

The bulk of the line ran over a very easy country. Jacqmin says that the cuttings were only about 3 feet deep, and the embankments about 5 feet high, except near the viaduct, where they were about 10 feet. The viaducts and bridges were of timber, with spans of about 16 feet, the timber being obtained from tradesmen or cut down in the neighbourhood. The ruling gradient was 1 in 40, and the maximum curve about 10 chains.

In the last week of September it was tried with locomotives, though it was not actually worked till 4th October, but when the autumn rain came on, the track settled in many places, and almost as many workmen were obliged to be maintained for its repair, as had been necessary for its construction. The traction became very dangerous, and several accidents took place; at Morville it is said that an engine lay on its side on the rails for several days. During this period of 26 days, the working was of a very moderate description. The locomotive only drew four waggons at a time, and sometimes the four waggons had to be uncoupled. It does not seem in fact that the railway was particularly well constructed; it cost a good deal of labour, time, and money, and did practically no work, and the fall of Metz at the end of September, relieved the German engineers from their difficulties.

The railways had heavy calls on them to transport the wounded and the French prisoners to Germany, and the latter did not always fare well;

some of them being kept for three days in open waggons in intensely cold weather, whereby some of them were frozen to death.

On the French side, the organization of the railway department collapsed in consequence of the general annihilation of the armies; and there is no doubt that Bourbaki's ill-success in the east of France, was in a great measure due to the ignorance of railway management.

At one period indeed, there is little doubt that a well organized raid on the railway between Toul and Blesure would have had every chance of successfully interrupting for some time the main artery by which the supplies of all kinds were sent from Germany to the armies before Paris, and might possibly have led to the raising of the siege of that city.

I have taken the liberty of conducting you through the various wars in which railways have played their part, and the lessons that may be learned from them are many and various, and I have felt how utterly impossible it is for me within the limits of a single lecture, to enter into details as much as I should wish. There are innumerable points in connection with these matters which would be of the greatest interest and importance, as illustrations of the subject, on most of which one hour's lecture might profitably be expended. But the lesson I wish more particularly to impress on everybody is this, that without a recognized military railway department, war cannot be carried on against first class powers at the present time with any prospect of success; that against all nations, whether civilized or uncivilized, the application of railways as a branch of military operations advances with rapidity the conclusion of such war, and consequently repays its own cost to an immeasurable extent.

As an example of what the Russians are doing in these matters, Captain Burnaby has given an account in his lecture in this Institution on the practical instruction of Staff Officers.* In 1869, a Special Committee was appointed to consider all matters connected with railways, and the result has been, that all the Railway Companies have to provide a certain number of carriages for wounded, fitted up with litters and well ventilated, and a number of carriages, waggons, and trucks, specially devised for military purposes.

They have moreover, formed a railway corps in the following manner. Eight officers and 432 men were distributed among the various railways, the officers for instruction more especially in the duties of station-master, and the men in the management of the line. After two years' practice, it was decided to test this corps during the annual manœuvres; they were therefore suddenly recalled from their respective stations, and formed into two companies of four officers and 216 men each, each company comprising engineers, engine-drivers, stokers, guards, pointsmen, signalmen, &c. An infantry division, and an engineer battalion, were ordered to assist in the work. This force constructed during the manœuvres, a line of seven versts in length in seven days, including two stations and ten bridges, one of which was about fifty yards long.

The Italians had recently arranged that each battalion of engineers in their army was to be augmented by one railway company, besides

* See Journal, No. 68, Vol. xvi, p. 633 *et seq.*

which, all the companies of engineers received a brief education in that kind of work, and consequently the engineer committee had issued a manual of instruction in two parts, the one relating to the construction of railways, and the other to the destruction and repairing of lines, in addition to which, the corps of engineers actually work two small lines of railway. But the Italians were not satisfied with this, and, keeping pace with the age, they have detailed a body of officers of all arms of the service to study the organization and execution of railways on the North Italy Railway; when this course of construction is completed, the officers will be called on to prepare a complete practical manual for working railways from a military point of view, in order to arrive at the formation of a technical staff capable of undertaking the direction of the service of the railways in time of war.

The Director-General of the North Italy Railway has, in concert with three very senior officers of the army, recently submitted a report on the military service of railways.

This report has been published in the "Railway Monitor," an Italian paper.

It recommends the establishment of a General Department, for the military service of railways at the war ministry, or at head-quarters, composed of a certain number of officers of all ranks and all arms, and directed by a general officer; they will also undertake the general direction of military transport. The department will employ in peace-time any surplus officers for directing the office work, and superintending the practical instruction of officers on the lines of railway.

For the transport service, six captains and six lieutenants of engineers and artillery will be thoroughly instructed in everything concerning the service of depôts of material, the employment of each kind of vehicle, the registering of their various capacities, and in the course laid down for the service of the men and the trains.

Service of the Line.—In order to have skilled workmen for executing the special work appertaining to railways, there will be established a special school for technical and constructive works at the head station of the Northern Italian Railway Company in Turin.

The school is formed of a brigade of two companies of sappers; some officers and non-commissioned officers taken from the other companies of sappers, will participate annually in the exercises of this brigade.

As it is not possible to pass the whole of the sappers through this school, they will be exercised in analogous works on the line of railway near their respective stations, on the same system as that established at the school; the principal exercises will be the loading and unloading of railway plant, in plate-laying, working signals and improvising bridges, &c. Whilst the railway company will have to construct new branches, effect repairs to the way, and the points and crossings, &c., the brigade will be able to furnish a certain number of workmen habituated to assist in the execution of such works.

Besides the officers and soldiers appointed to familiarize themselves with the service of the line, there will be detailed annually for the special study of the organization of the service of the North Italy

Railway Company, twelve officers of engineers, half of whom will be captains, and half lieutenants; they will at the end of their course of practical instruction, present reports on the object of their studies, they will have to furnish projects on the improvements which appear to them necessary from a military point of view, on putting the stations in a better state of defence, in the destruction of artificial works, &c.

Owing to these works being prepared previously, the Minister will, at the given moment, have nothing to do but order their execution.

The service of the trains is not as easily prepared for by a military staff as that of the construction of the way, but if one is unable to rely on the mechanics, one can always withdraw the firemen from the technical brigade. In time of war, these latter could replace those of the company, being under military law, men who could, by reason of their great experience, be promoted mechanics for the working, more especially at those points of the lines most exposed to danger.

Recruiting of the Workmen for the Railways.—In the annual sub-division of the contingent, we should tell off for the railway brigade such men as have been employed on railways; these men on being discharged will pass into the militia, and if necessary can be recalled into the railway brigade, and will wear on their ordinary clothes a badge with the inscription "Railway Brigade."

They also consider it possible to organize in time of war, a corps entitled railway volunteers, drawn from the civil establishment of the railways, who will be subjected to military discipline. The nucleus of this corps can be prepared during peace by the Minister, the term of service being one year.

The other railway companies are to be organized in a similar manner to that of Upper Italy.

The report has been made chiefly with the object of adapting the military requirements in time of war to the ordinary service of the various railway companies.

To carry out these arrangements a special decree has been passed to the following effect:—

The Government will appoint a Military Commission to be attached to each of the chief railway companies in the kingdom, whose powers are fixed by royal decree. The Government also concur in the suggestion that the commission shall be composed of superior Officers of all arms, of two functionaries from the Ministry of Public Works, and of a superior locomotive superintendent from each of the great railway companies, who shall in peace time have a voice in the consultations regarding railway works, the permanent and temporary lines; in time of war, these commissions can be charged with the general direction of the railways.

The regulation of existing railways is a subject intricate in detail, abounding in statistics, and which must be left to the determination of the department, which must ere long be organized. Indeed, a provisional committee has, it is understood, been recently established to consider these matters, and it will be readily understood how much time and attention requires to be bestowed thereon.

I will therefore direct your attention more especially in this lecture to one special branch of the subject which comes very prominently before us Englishmen, and that is the construction of entirely new railways in time of war.

The first point that occurs to most people is what is to be the gauge of such railways. But the fact is, that gauge is entirely dependent on circumstances. In England our lines are, with hardly an exception, of the 4′ 8½″ gauge, and thousands of engines and many thousands of vehicles are available for use daily. It would therefore never be practically advantageous to construct lines other than of the ordinary gauge in our own country if she were engaged in war, within the limits of Great Britain. In Ireland the case is somewhat different, the gauge is 5′ 3″, and an unsatisfactory gauge it is in many ways, exceeding the requirements of the country, and carrying rolling stock bearing an undue proportion of dead weight to the quantities of goods, &c., transported, and which could not be supplemented from England in case of an invasion of that country. It is worth considering whether the Irish railways should not be assimilated in gauge to that of Great Britain, the rolling stock changed at the expense of the State under certain conditions, and the new rolling stock made of the patterns which may be considered most suitable to military requirements and equally advantageous for civil requirements.

But our last wars have been expeditionary wars, and the probabilities are in favour of such wars being those in which we are most liable to indulge in at present; it is therefore worth our while to consider and discuss what sort of railway we could best use to further this object and economize the cost of the expedition.

As you have seen, in the Crimea we took several months to make about 5½ miles of semi-railway semi-tramway; and in Abyssinia it took several months to make about 12 miles of railway, on which much difficulty was experienced in providing for the wants of an army of about 13,000 men.

The return on the 1st May, 1868, gives:—

13,449	501 Officers.
	3,972 European troops.
	8,976 Native troops.
20,295	followers.
330	civilians.
2,538	horses.
40	elephants.

For the majority of most foreign countries, the gauge of the existing railways is also 4′ 8½″, and the same remarks which apply to our own country, apply almost equally to such countries. India is, unhappily, in a state of war at present, racked and wrecked with the everlasting battle of the gauges, and perhaps the less I say about it the better, for in the discussion which will, I hope, be introduced by this paper, it is not my desire to provoke a protracted discussion on a point on which so many people differ, and on which so many people have recently expressed their views at the Institution of Civil Engineers.

But so much has been said about the matter lately, and the study of our relations with Central Asia is being brought with such prominence before us, that I cannot refrain from observing that any railway extension beyond the mountain barriers of our Indian Empire, whether into Persia, China, or Russia, cannot be advantageously, or with any prospect of financial success be so extended on the existing 5′ 6″ gauge. In mountain lines the narrowness of gauge is of vital importance.

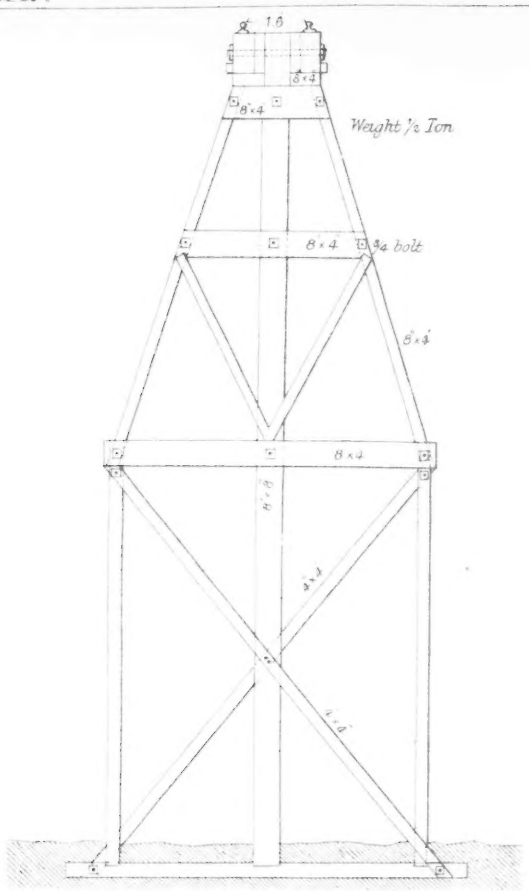
In the construction of a new railway in war, economy of men is of more consequence than economy of money, and economy of time is of greater importance than either. The point is therefore, what sort of railway can be constructed in the shortest time, with the smallest number of men. If it is expected that the troops of the line are to assist in its construction, there is one difficulty which we immediately stumble over, and that is, that the smaller the army, the less number of men can be spared for employment on works, and *vice versâ*, whereas the smaller an army, the greater is the average length of its daily march, and *vice versâ* again; therefore, if the construction of a railway has to keep pace with the march of an army, and I cannot consider the result to be satisfactory which does not effect this, it is in reality a matter of calculation whether it is possible to make a railway at all, and with what sized army? For instance, we know that for a very small body of men, no railway of however diminutive a nature would be of advantage, and if in an enemy's country could not be guarded, if of any length.

There are several railways of a diminutive nature now in use for special objects. At Crewe, in the works of the London and North Western Railway, in Woolwich Arsenal, and in Chatham Dockyard exist lines of only 1′ 6″ gauge; that in Woolwich especially, transporting enormous weights; the locomotive for it weighs six tons, and has a wheel base (*i. e.*, the distance between the axles) of 3′ 8″, allowing it to pass readily round curves of very small radius; these lines are all on the level, or nearly so.

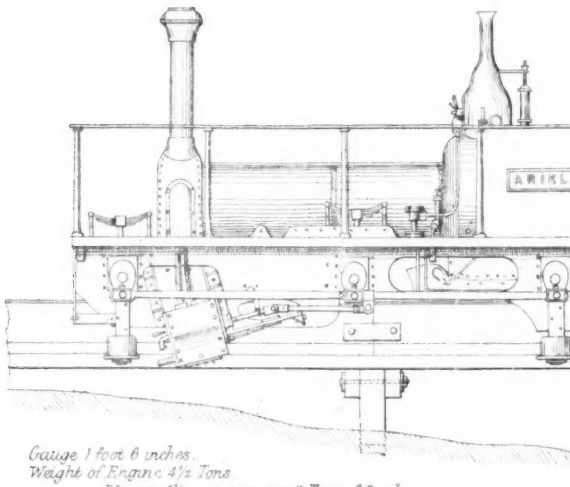
Another line of the same gauge has also been recently constructed at Aldershot as an experiment, under the auspices of the Royal Engineer Committee. This line, and more especially the rolling stock used on it, exhibit many novel features, and were designed for the War Department by Mr. J. B. Fell, the celebrated engineer of the Mont Cenis Railway, who also superintended its construction. (See Plate.) He has himself described it in a lecture given by him to the United Service Institution, at Plymouth; and I cannot do better than state very much in his own words, the reasons for his adoption of this form of structure, and the details of its construction:—

"If," says Mr. Fell, "the problem presented to us for solution is, "that of making a given length of railway, with a given number of "men in the least time, or the limit being fixed to the number of men "and time, to make the greatest possible length of railway, then it is "evident that the solution must be found principally in an improved "method of executing the earthworks, masonry, and ballast, or their "equivalents, since it is in these usually that more than nine-tenths of "the whole work consist.

FELL'S FIELD RAILWAY AND ROLLING STO



End Elevation of a 20 feet Support or Tressle

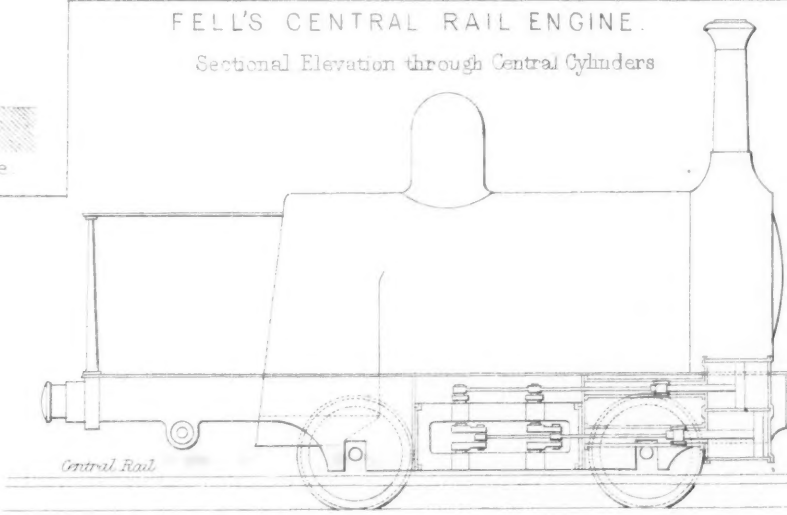


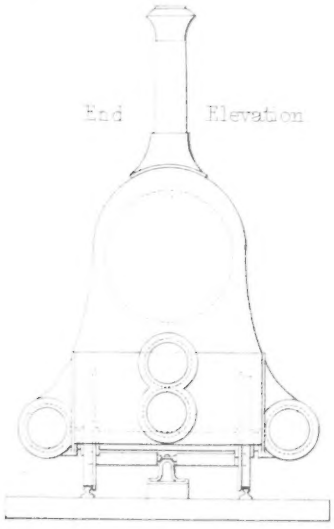
Gauge 1 foot 6 inches.
Weight of Engine 4½ Tons
" " Waggon 1½ " carrying 3 Tons of Goods
Rails 20 lbs. to the Yard
Carrying beams 10 × 5.
Spans 10 feet.
Maximum Curve 10 Chains
Rising Gradient 1 in 50
Extreme height of Tressle Viaduct 24 feet
Weight of 1 Mile of Line 150 Tons.

12 6 0

FELL'S CENTRAL RAIL ENGINE.

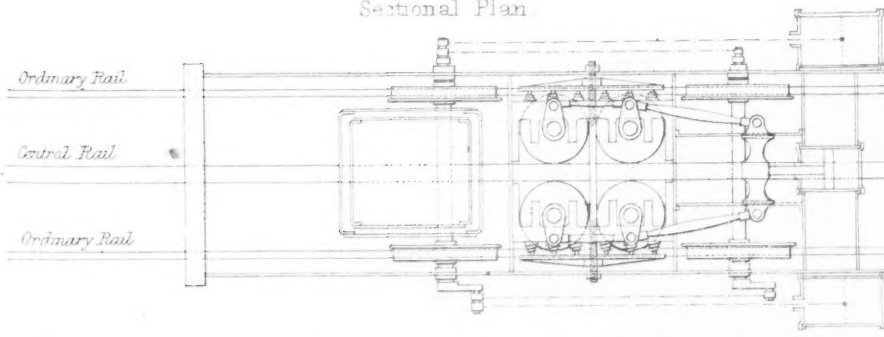
Sectional Elevation through Central Cylinders



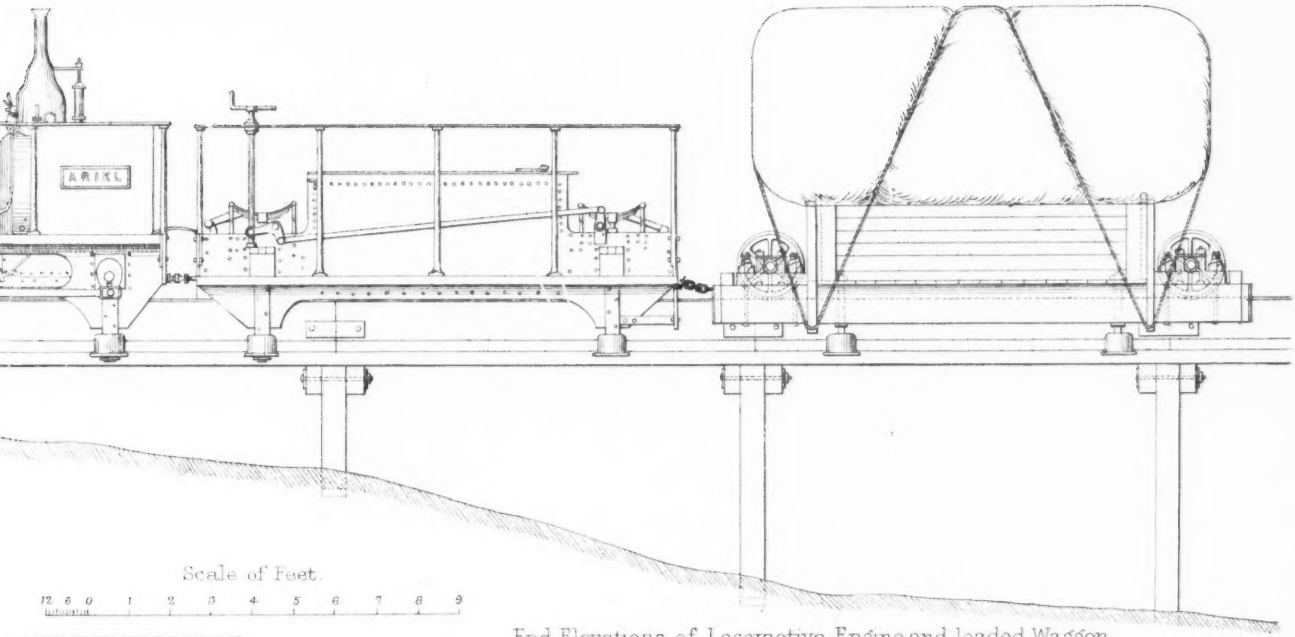


Wheel Base	7	0
Diam.r of driving wheels	2	3
D.o centre wheels	1	7½
Gauge of Line	3	7½

Sectional Plan



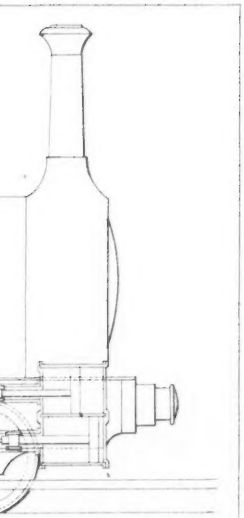
LING STOCK, ALDERSHOT.

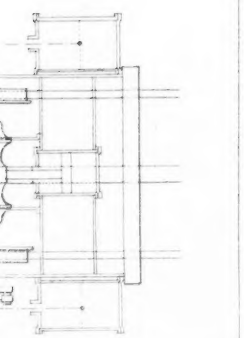


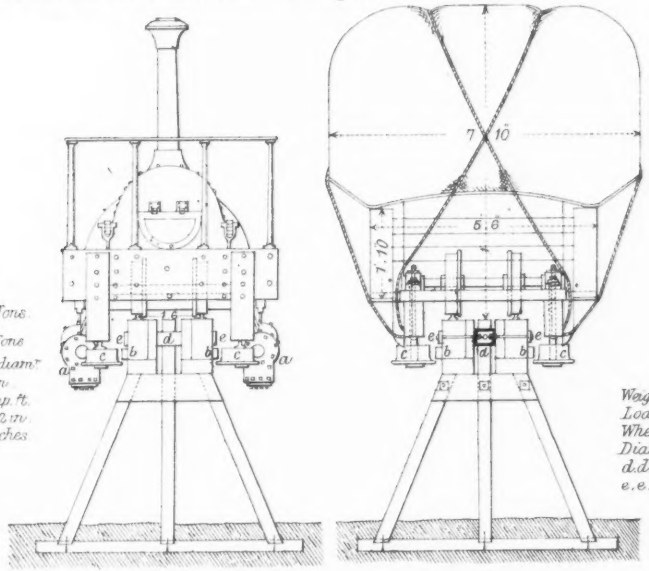
Scale of Feet.

12 6 0 1 2 3 4 5 6 7 8 9

End Elevations of Locomotive Engine and loaded Waggon.







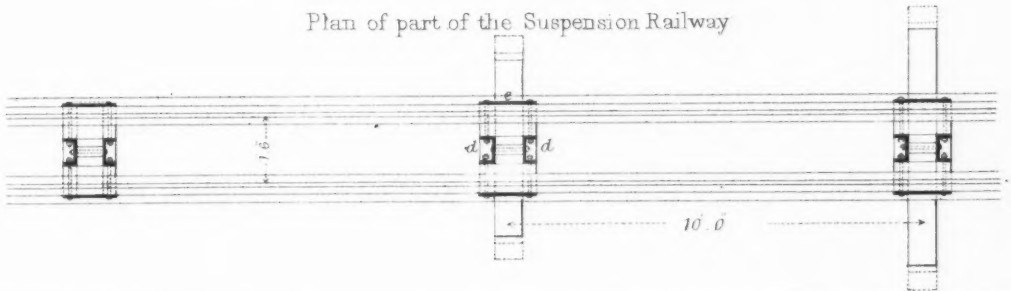
Weight of Engine	4½ Tons
Tractive power in a ruling gradient of 1 in 50	22 Tons
Cylinders	10 in diam^{r}
Stroke	6½ in.
Heating surface	78 Sup. ft.
Wheel base	10 ft. 2 in.
Diam^{r} of Wheels	16 inches

a.a. Cylinders
b.b. Guide rails
c.c. Guide wheels.

Weight of Waggon	1½ Ton
Load	3 "
Wheel Base	10 Feet
Diam^{r} of Wheels	16 inches

d.d. Iron Brackets
e.e. Fish Plates.

Plan of part of the Suspension Railway



J. Jobbins

"As there is no known method of executing earthworks, or of "building bridges and culverts, with greater expedition than that in "general use, and which simply consists in increasing the number of "men, the plan I have adopted has been to dispense with earthworks, "masonry, and ballast, altogether, or nearly so, and to substitute for "them a continuous structure of timber, upon which the rails are laid. "This method of construction renders it necessary to adopt an ex- "ceptionally narrow gauge, and the extremely narrow gauge necessi- "tates the introduction of peculiar arrangements into the locomotive "engines and carriages.

"The structure consists of a double beam of timber, resting on "timber supports sunk a very slight depth in the ground, and placed "at variable distances apart. The supports are made of a vertical "post and two side struts, resting on a sleeper, and connected at their "upper ends, by two cross pieces, which, together form a kind of "triangular frame, and furnish at once the carrying power and stability "necessary for supporting the weight, and resisting the lateral oscilla- "tion of the running of the trains; the beams are made continuous by "means of fish-plates at each joint, and are firmly secured by three "bolts passing through the centre part, and through the whole width "of the structure."

Experience shewed that where curves occurred these long bolts were not easy to manage, the bolt holes not readily coinciding; and an experiment is now being made in substituting iron brackets or boxes for certain of the wood fishes, and filling pieces, and bolting with quite short bolts. It remains to be seen whether they will answer, but they add much to the rapidity of construction. The structure consists in fact of two parts, the double beam and the supports, with the addition in the widest span of longitudinal struts.

The ruling gradient of the Aldershot line has been made 1 in 50, and the maximum curve a little more than 3 chains. On this the conditions were, that an engine not exceeding 6 tons weight was to draw a load of 30 tons. The builders, however, miscalculated, and made the engine only $4\frac{1}{4}$ tons: it has a rigid wheel base of about 10 feet, carried on three pairs of wheels, all coupled; the weight therefore on each pair of wheels, or on any 5 feet of the structure does not exceed about $1\frac{1}{2}$ tons. Its tractive power on the most severe part of the line is about 22 tons.

To overcome any tendency to upset, the centre of gravity of the engine has been carried as low as possible, and is in fact only 8 inches above the rails, the cylinders, as you observe, hanging down on each side of the structure below the level of the rails. Safety is furthermore obtained by what are termed guide wheels, *c.c.*; these are horizontal in position, hanging on spindles, attached to the sides of the engine and waggons, and rotate against the guide-rails whenever they touch the side of the structure, from which they are separated about half an inch or so; one pair are placed near each extremity of the engine. To still further ensure the stability of the engine, these guide-wheels are single flanged, the flange biting when necessary under the edge of the guide-rail.

"Consequently although the gauge of the Aldershot Railway is only "18 inches, it becomes by these special appliances, equivalent to a gauge "of 3′ 6″ by the additional 1 foot of lateral support, on each side of "the structure, given by the horizontal wheels acting on the guide "rails.

"The method of construction is as follows: A section having been "taken over the ground, and the heights of the rails above the surface "ascertained, the materials would be distributed along the line, suitable "supports having been selected from the stock of assorted lengths sent "out from England. A force of 400 to 500 men would then be sufficient "to construct a length of one mile of railway per day over an ordinary "country, with embankments varying up to 20 feet in height, and as "the railway is made it will carry forward its own materials from the "landing port into the interior, so that much less than the usual amount "of carting would be required. The erection of the structure would be "commenced at a number of points simultaneously, and be carried "forward in the two directions, until the different sections met, and in "this manner within a short period, an almost indefinite length of rail-"way could be constructed, reaching from the base of operations to "the rear of an army in the field."

Now this Aldershot line is probably of the narrowest gauge on which a locomotive engine could work, and Mr. Fell states, "That on a single "line of this description with passing places two miles apart, 25 trains "could be run in each direction in a day of 12 hours; and that, with a "ruling gradient of 1 in 100, each train drawn by one engine would "carry 40 tons of stores, and could thus effect the transport of 1,000 "tons per diem."

This 1,000 tons is the result of the following calculation: The provisions, forage, fuel, &c., consumed daily by a *corps d'armée* of about 22,000 men is about 200 tons, but this includes forage, &c., for a large amount of supplementary transport animals, which could be dispensed with if a field railway were used, and in that event the weight to be carried per diem would probably not exceed 170 tons.

Therefore, for 100,000 men the weight to be transported would be about 800 tons, and as it is improbable that England will ever have a larger army than this in the field, in any foreign war, 1,000 tons is probably the maximum that a field railway would ever have to carry in a day. I will therefore revert to the calculation of men required to make it. It is doubtful whether one could depend on a larger proportion than one-tenth of an army being available for employment in railway construction. Assuming that a railway, such as that at Aldershot, can be made at the rate of one mile per day with 500 men, and that whilst an army corps of 22,000 men could march on an average 12 miles a day, an army of 100,000 men could march only an average of 8 miles a day, it results that the smaller army corps could, with one-tenth of their strength, only make about 4 miles of line per day, whilst the larger army, with the same proportion of workmen, would have no difficulty in constructing daily its 8 miles or so of railway. On these bases, the calculation can be founded that an army of about 60,000 men could construct, with one-tenth of their strength, the same

length of railway per *diem* which would be the average distance that number of men could march, viz., about 10 miles, and that, with an army of greater strength, a greater length of railway could be, if necessary, made. These, like all calculations, are of course open to criticism, but I have no hesitation in recording my opinion that a railway capable of carrying all the munitions of war for an army of about 100,000 men could be constructed by it at the same rate at which that army could march.

I do not, however, think that it would be possible to do this, or anything like this, if the ruling gradient of the line be limited to 1 in 100, unless the country were singularly favourable, or if the radius of the curves was limited to 3 chains. But we cannot pick and choose the country in which our campaign may require to be undertaken, and if any considerable length of line were required, the topographical features of the country would invariably necessitate peculiarities of construction. If the gradients were limited to 1 in 100, or thereabouts, viaducts of considerable height would be constantly occurring in a moderately hilly country, and in a mountainous country, would be formidable works to construct, whatever material they may be made of. As portability is the essence of rapidity in construction, so should we avoid the use (in the first instance, at all events) of cumbrous and very weighty trestles. The 20-foot trestle, shown in the Plate, weighs half-a-ton. To enable this to be done, it would be necessary, in laying out the line, to study and to follow, to a great extent, the sinuosities of the country and the varying levels of the ground; and I think that if this were done, and much greater latitude given to the curves and the gradients than has been given to the Aldershot line, one might fairly calculate on being able to erect, with the necessary celerity, a given length of railway with a given number of men.

But, as the steepest gradient in a line of railway rules the load which can be drawn by any one engine, it consequently rules the gross load which can be transported daily on that line. Now, although 1,000 tons may be the maximum weight of stores which might be required to be transported in any one day, we must add to that the weight of the line itself, the whole of which would have to be deposited at the terminus of the line in time to enable the work of the following day to be proceeded with. This is something considerable. The Aldershot pattern of railway weighs about 150 tons to the mile on an average country, and if 10 miles of railway is to be made daily, the total weight to be carried daily would be about 2,500 tons. I have no hesitation in saying that I do not believe the Aldershot line capable of performing that work.

But increased power in the engine is in a great measure synonymous with an increase of weight, which necessitates heavier rails and increased strength of structure.

We will assume, then, that to do the work, a structure is required similar in principle to that at Aldershot, but weighing 200 tons in place of 150 tons to the mile, and that, consequently, the total daily weight of transport is about 3,000 tons. The problem, then, for consideration is, how is a load to be carried three times the weight of the

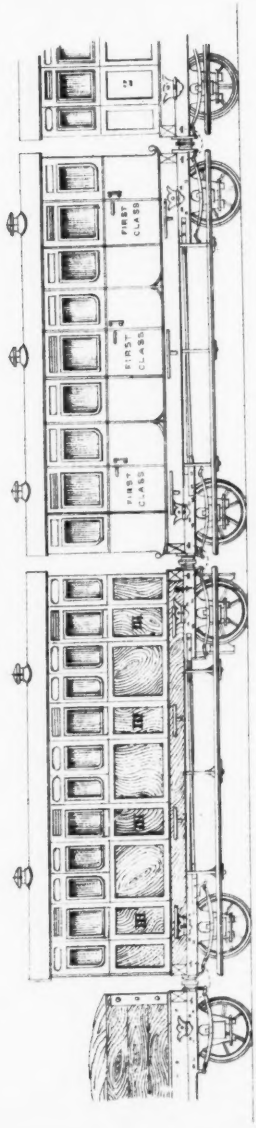
maximum capacity of the Aldershot line on a railway with steeper gradients and sharper curves than that line possesses?

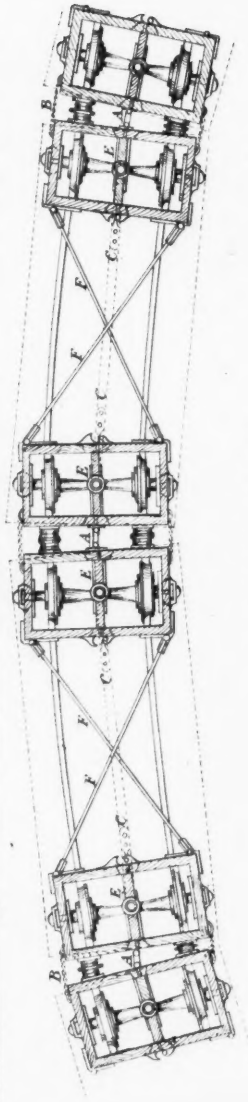
I believe that the most powerful engines that have yet been built for working on other than extraordinary gradients, are the "Fairlie" double bogie engines, the adoption of which, more especially on railways of unusually narrow gauge, has enormously increased their capacity for transport. On the Festiniog line in North Wales, which has a gauge of only 1′ 11½″, one of Mr. Fairlie's engines, the "Little Wonder," weighing about 20 tons, has drawn a train of 213 tons gross weight, carrying 144 tons of goods, over the steepest gradient (1 in 60) on that line without difficulty. The principles of these engines are chiefly that the fire-box and boilers are pivoted upon two separate platforms or "bogies," each resting upon two, three, or in some cases four pair of coupled wheels. The result is that the platforms adapt themselves to every sinuosity of the line, so that they may easily be traversing at the same time different parts of a reverse curve of short radius; and thus the length of the engine as a whole may be greatly extended, and any reasonable amount of power, that is, of boiler and fire-box surface, may be given to it. Furthermore, its weight is distributed over its eight, twelve, or sixteen wheels in a manner most favourable for adhesion. As the minimum radius of the curve round which an engine can run, must be proportioned to the wheel-base (in combination to a certain extent with the gauge of the line), this double-bogie arrangement has simplified the question of curves very much. The "Little Wonder," having a wheel-base to each bogie of 5 feet, can traverse curves of one chain radius with the most perfect ease.

For ascending steep gradients, the system adopted by Mr. Fell on the Mont Cenis and other lines, is one which gives very great increase of power; it is that known as the "centre rail," and Mr. Fell has been good enough to lend me some drawings of a locomotive illustrating that system, enlarged copies of which you see on the wall. (See Plate.) He provides his engine with horizontal wheels, worked by separate cylinders to those which work the vertical driving wheels, thus obtaining from one engine an extraordinary amount of adhesion, and enabling gradients to be ascended which were hitherto considered impossible. My impression is that an engine combining the double-bogie and the centre-rail systems, would produce the most satisfactory results, and that for a military field railway such engines would facilitate very much the work required to be done, more especially in steep descents, a third or centre rail being attached to the structure wherever the gradient of the line was necessarily steep.

We estimated that 3,000 tons was the weight required to be carried daily on a line to enable 10 miles to be constructed daily, and if we assume 25 trains as the maximum number per diem, each train must carry an average of 120 tons, but as one could scarcely depend on being able to load each train with exactly the same weight, I think we shall not be far wrong in fixing 130 tons as the maximum weight for each train. The "Little Wonder" drew 144 tons of goods on a gradient of 1 in 60, but her load was distributed in 77 little four-wheeled waggons weighing each with its load only 2½ tons, giving very little more than half

THE FLEXIBLE FOUR WHEEL STOCK
(GROVERS PATENT.)





a ton of load for every lineal yard of the train. For military purposes such small vehicles would not be necessary, and would have many disadvantages. The weight on each axle rules, to a certain extent, the strength of the structure, and the greatest strain thereon would be caused in a field railway, by the engine; hence the weight on the axles of the waggons may be made to suit circumstances. Therefore if the gauge would have admitted of waggons containing 6 tons being used on the Festiniog line, the number of axles in the "Little Wonder's" train, which, by the bye, stood on several reverse curves, would have been 44 in place of 144, the total length of the train would have been about 120, in place of 240 yards, and, under those circumstances, she could have drawn a total net load very considerably exceeding 144 tons. You will, therefore, perceive that the nature of the waggons used for transport is a subject of the utmost importance, influencing the capacity of a line to a singular degree.

The capacities of waggons depend more on their width than anything else, and the safe width depends on the gauge. It has been found in practice that a waggon 2½ times the width of the gauge will travel with perfect safety; the waggons in use on the ordinary English railways are not so proportioned, because in the first place, they would be unwieldy, and in the second place, it would make a serious difference in the width required for a double line railway.

On the other hand, in the Aldershot line, Mr. Fell's waggons manage to carry loads between five and six times the width of the gauge of the line. The waggon shewn in the diagram (see Plate XXXVI) was drawn at the tail of a train at a speed of about 15 miles round a curve, without any serious oscillation; it carried 100 tents, sufficient for a battalion of 1,000 men, and weighing a little over 3 tons. You will see that in this waggon the wheels are placed at either end, the body of the waggon being in a manner slung between them; by this means a very low centre of gravity is procured, the floor of the waggon being only a few inches above the level of the rails, but it has a rigid wheel-base of 10 or 11 feet, limiting the curve round which it can traverse to about 3 chains.

There is, I think, no doubt that a four-wheeled waggon is that best adapted for transport, and for giving the engine the greatest tractive ease, but the difficulty has hitherto been to obtain a short wheel-base with a good length of waggon, and yet the wheel-base should not be less than twice the gauge of the line. Mr. Grover has, however, produced an arrangement by which these difficulties are overcome, viz., by attaching hinged rods to the extremities of frames to which each of the axles is attached; these frames work on centre pivots under the body of the waggon, and by this cross-bracing each pair of wheels takes the exact line of the rails when on a curve, and the frictional resistance of the flanges of the wheels against the rails is reduced to a minimum. (See Plate). I would propose, then, to use for a field railway, waggons with a wheel-base of about 8 feet with cross-braced axles, the total length of the waggon about 12 feet, with a width of 7′ 6″; they should weigh about 3 tons, and have a carrying capacity of 9 tons.

The gauge of railway on which these waggons would be used, should be about 3 feet, and this gauge would be very suitable for a double-

bogie centre-wheel engine, weighing about 30 tons. The weight on each axle of a waggon would be 6 tons, and on each axle of an engine with four-wheeled bogies would be $7\frac{1}{2}$ tons. The wheel base of the bogie to be about 6 feet, allowing sufficient space between each pair of driving-wheels for the horizontal wheels. Such engines would, with waggons of the above description, take the required load of 130 tons up an incline of about 1 in 40, and a train, with two such engines attached, could surmount about 1 in 20. It is very rarely that steeper gradients than this would require to be encountered, if latitude be given for small radii in the curves.

It would probably be best to station at the extremities of the steepest inclines, a certain number of extra engines, which could be attached to the trains as they arrived and help them up and down. This rolling stock would also be able to traverse curves of one chain radius.

The quantities of rolling stock required for actually working the line would be 50 engines and about 500 waggons, and if we add one-fifth for rolling stock out of repair, it results that the quantities required would be 60 engines and 600 waggons. Beyond a distance of about 100 miles, they would have to be proportionately increased in number. Each of these waggons would have capacity sufficient to transport men, wounded or otherwise, and animals.

The greatest weight on any axle being $7\frac{1}{2}$ tons, a "bridge" rail of about 30 lbs. to the yard, would suffice for the work, carried on beams 12 inches deep by 6 inches wide, the distances between the trestles about 10 feet, and the trestles themselves made of the desired stoutness: the carrying-beams, and centre beam, to be attached to the platform of the trestles by iron knees.

I don't pretend to say that these dimensions are exactly those which would be found in practice to be the best, but they approach sufficiently near to the truth to be able to state that such a line would weigh approximately 200 tons to the mile, and could effect the daily transport of the 3,000 tons of load which are necessary to enable a railway, for the service of an army of 100,000 men, to be constructed at the same rate at which that army could march.

But there is another very important item in the construction of the line, and that is the transport of the various parts of the structure from the terminus of the line to the several points at which the workmen would require to commence simultaneous erection. This would necessitate the employment of a large number of vehicles, a considerable number of horses, and the roadways would frequently be of indifferent order, or of no order at all. I admit it to entail certain difficulties, but if we are employing an army of that size, the crisis will be a serious one, the struggle will be one of severity, and we must not hesitate, in those times, to adopt large measures, whatever may be the immediate cost; nor is it economy to hesitate in peace-time about the cost of carrying out experiments which must conduce to success in war, and which is consequently the soundest of political economies.

I will now conclude, Sir, by drawing the attention of every person in this room most earnestly to the startling fact that whilst Russia, Germany, Italy, Austria, and France all possess organized and well

recognised departments for the military management of railways, *we* are but just beginning to awake from the lethargy which but recently pervaded the mind of the country regarding the conduct of war. It is foolish and unnatural to entertain, with any seriousness, the ideas which do however acquire a certain amount of strength the longer peace lasts, viz., that war is improbable, that war will not come all at once, and so on. I say distinctly and emphatically, that no dependence whatever can be placed on such suppositions, and that if we went to war to-morrow, the almost utter ignorance of railway management, in all ranks of the army, would place it in this, as I fear also in many other respects, in a false position, and not on equal terms with a civilized opponent. It is with these impressions that I have ventured to put my humble shoulder to the national wheel, and to endeavour, in so far as I may be able, to point out what seems to me to be a great want, and a blot on our military escutcheon.

Appendix A.

Table No. 1.

Federal Army, 1863—Construction Corps.

6 Divisions.

Each division—Five subdivisions and a train-crew.

Subdivision No. 1.

Supervisor of bridges and carpenters' work	1
Clerk and timekeeper	1
Commissary	1
Quartermaster	1
Surgeon	1
Hospital steward	1
Foremen (one for each 50 men)	6
Sub-foremen (one for each 10 men)	30
Mechanics and labourers	300
Blacksmith and helper	2
Cooks	12
	356

Subdivision No. 2.

Supervisor of track	1
The remainder the same as in No. 1 Subdivision	355
	356

Subdivision No. 3.

Supervisor of water stations	1
Foreman	1
Mechanics and labourers	12
Cook	1
	15

Subdivision No. 4.

Supervisor of masonry	1
Foreman	1
Masons and labourers	10
Cook	1
	13

Subdivision No. 5.

Foreman of ox brigade	1
Ox drivers	18
Cook	1
	20

Train Crew.

Conductors	2
Brakemen	4
Locomotive engineers	2
Firemen	2
Cook	1
	11

Staff.

Division engineer	1
Assistant engineer	1
Rodman	1
Clerk	1
Messengers	2
	6
Total	777

Total of corps nearly 5,000.

Appendix B.

Detail of Plate-layers, Abyssinian Railway.

Divided into 4 parties, as follows:—

1st party.—2 non-commissioned Officers 8 men (natives)	Laying sleepers at proper intervals, and fish-plating rails.
2nd party.—1 foreman civilian ..... 1 native ganger ..... 8 men (augurs) ..... 8 men (hammers) ..... 8 men (crowbars)	Spiking rails to sleepers.
3rd party.—1 foreman (civilian) ..... 1 non-commissioned Officer (platelayer) ..... 1 native ganger, with party varying from 20 to 50 men	Levelling, raising, and adjusting the line to enable the ballast trains to pass over it.
4th party.—1 foreman platelayer ..... 1 non-commissioned Officer platelayer ..... 2 gangers with 2 gangs (native) from 40 to 100 men.....	Ballasting and finishing the line.

The Chairman: We are all very much indebted to Captain Luard for the able paper he has just read with regard to the application of railways in time of war. We are also indebted to him for having shown the necessity of having an organized railway corps in this country. I know it has been argued that we have a very large supply of railway labour and material always available, but I am perfectly certain that we require an organized military railway corps with our army as much as we require organization in the other branch of the service. We shall be glad to hear any gentleman who may wish to speak on this subject.

Major Powell: By permission of the Chairman, I wish to make a few remarks founded upon personal observation, with reference to the Balaclava railway which has been alluded to in the interesting lecture which we have just heard. In the month of March, 1855, I was appointed to despatch from its upper terminus all the arms, ammunition, and other munitions of war to the army before Sebastopol. I was subsequently, in the month of July, placed upon the staff of the army as Deputy Assistant Quartermaster-General, and entrusted with the chief superintendence and management of the line. I will trespass upon your time a few minutes to point out the difficulties which were apparent in the working of that railway with undisciplined men, and also the great advantages which accrued when it was worked with discipline. On the opening of the line, it was worked by the corps of navvies who had constructed it, but as they were not in a proper state of discipline, grave difficulties occurred. They often times struck work when their services were most urgently needed. The late Mr. Beattie, the civil engineer in charge, exerted himself to the utmost to work the line successfully,—he acted most zealously and patriotically, but unfortunately broke down; he was sent home seriously ill, and died soon after his arrival in this country. On my taking over the line, I considered it best to recommend that these men should be sent home, and their services were replaced by some

men from the Army Works Corps, and by the whole of the N division* of the Land Transport Corps, who were in a proper state of discipline, and worked admirably. Many of them lost their lives in the execution of their duty, and when I required them to work night and day to throw forward supplies for the final struggle, the capture of Sebastopol, several of them to my personal knowledge remained 72 hours continuously at their posts. The traffic on the line, when it was worked with undisciplined men, never exceeded 200 tons per diem, but when it was worked by men in the proper state of discipline, it rapidly increased to 700 tons. I make these references, because I think some preparation ought to be made. From my experience, I came to the conclusion, that in all future wars, railways would render material aid in facilitating the rapid transit of troops and supplies, and the part which they played during the late Franco-Prussian war fully confirmed my opinion. I therefore consider it highly essential on the part of the Government that a small force should be enrolled for the purpose of forming the nucleus of a corps to be at all times ready to construct and work these railways. I do not know that I can say anything more with reference to railways, but I should like to say a word or two about transport as the one question is mixed up with the other. I believe I am justified in saying I have had more experience in the organization and command of transport, than any other officer of the army; and from my experience, I believe that the present system is not in that state in which it ought to be. I am strongly of opinion that the General Officers in command of divisions ought to have the means placed at their disposal to enable them to move all the troops within their respective commands, with their camp equipage, ammunition, and three days' rations of provisions without reference to any other authority whatsoever. The present numbers of the Army Service Corps barely suffice to move 10,000 men; consequently the Control is busy purchasing and selling horses seven or eight months in the year. Such a system may be all very well for the horse-dealers and auctioneers, but I doubt very much whether it is at all well for the efficiency of the army, or for the benefit of the taxpayers. Not many years ago an officer in command of troops could press transport; that power being taken away, in my humble opinion some other power ought to be substituted, so as to keep pace with the requirements of the age.

Mr. GROVER, M. Inst. C.E.: I must apologize for addressing you as being a non-military man, but as Captain Luard has been so kind as to bring forward my invention in connection with railways, I should like to say one or two words on a few technical points. When railways were first constructed, they were made almost entirely straight, or as straight as they could be, and a half-mile radius was thought the very outside that was possible. Consequently, when the old stage coach came to be converted into the railway carriage, the pivoting arrangement of the front axle was entirely dispensed with. As we have gone on progressing, we have found that railways have gradually had their curves diminished from half a mile down to ten chains, five chains, three chains, and the more you diminish the curve, the more can you command a country with which you have to deal. That being the case, and being myself engaged in laying out certain railways where I have severe curves to deal with, I thought it was only necessary to endeavour to revert as near as I could to the old stage coach prototype, and in fact to do what an ordinary omnibus does, viz., allow wheels and axles to adjust themselves to the curves; the result has been that wheel-base invention before you which is showing most satisfactory results. I need not say anything about the engine, because that has already been so ably explained to you by Captain Luard, and any words I could say would be superfluous, but I should like to draw attention to one thing. I think it is always right that we should in these matters keep steadily before our minds the leading points; the A B C of the whole question, because it is really that A B C which gets so forgotten by scientific men when they come to deal with these things in practice. If we take two pieces of iron and put them one on the top of the other, we find the upper piece of iron will begin to slide on the lower piece when it is raised at an angle varying from one in four to one in six. That therefore is the limit of the gradient which it is possible for a locomotive engine to ascend. If this iron be exposed to a shower of

* On the reorganization of the Land Transport Corps, the N division was formed into the 8th battalion.

rain, or fog or damp, the upper piece of iron will slide at a much less angle, that is to say, 1 in 10. Therefore about 1 in 10 is the limit of the actual gradient it is possible to work in England. Now if a locomotive engine will just go up a hill of 1 in 10 by itself, it comes to this, that up 1 in 20 it can take a load equal to itself behind it, and up 1 in 30 twice that load, up 1 in 40 three times, consequently if we have an engine weighing 20 tons we can, up 1 in 20, transport 20 tons weight behind it, and up 1 in 30, we can transport 40 tons. Then comes the question what is really the actual gradient that you can get in dealing with a country? That certainly depends to a great extent upon the country. I have surveyed a great many miles of railway myself. Last year I had to report on and examine nearly 400 miles in different parts of Europe, and I may say I have nearly always found that in a country however severe, I could manage to get 1 in 30, provided I could only wind about as much as on an ordinary road. Therefore it all resolves itself into a question of curves, and, having got a system by which I could carry out a very severe system of curves, I can practically command a country by the mere adhesion of the locomotive wheels upon the rails. I would just give you a few practical results as to the cost of constructing very cheap mountain lines. Last year I had to lay out one in the north of Ireland, another in the Austrian Alps, and examine two or three more in the Carpathian Mountains, and in other parts; and I found almost invariably I could make what the Americans call the "roadway,"—(that is to say, that part of the line which is underneath what is technically called the permanent way), on the three feet gauge, for a sum ranging from £1,000 to £2,000 a mile, and that I could get through in nearly every case, with generally under 10,000 yards of earthwork to the mile. That could only be effected by the severity of the curves, and if I had not had the means of using Mr. Fairlie's system and my own invention, I should have been compelled to have had earthworks in many of these cases, amounting to 40,000 and 50,000 yards to the mile. Where you can reduce the amount of earthwork so low as that, it becomes to my mind a great question whether it is not better to use mere earth itself in preference to any scaffolding or staging which can be put up. You had better employ no stages at all, but simply use the old invention of the Barlow rail for temporary military lines. I had better explain what that was. It consisted of a rail with a very wide base of twelve inches, and this was simply laid upon the ground. It has occurred to me, looking at the question in a military point of view as well as I can, that if I were to fight anybody, I should take a quantity of these Barlow rails, and I should get the country surfaced as fast as I could and lay these rapidly through it, because after all as I understand the whole question, war consists in being beforehand; when an enemy has ten men, bring twelve against them, and so by rapidity overcome his forces. I think it is Marshal Saxe who tells us that legs are more important in military matters even than arms; therefore strike your blow rapidly, sharply, and at as many points as ever you can. I will not venture to trespass any longer upon your forbearance, but I think it will be found after all that the question of gradients does very much resolve itself into the question of curves.

Lieutenant-Colonel LEAHY, R.E.: There is so much in what the last speaker has said with which I cordially agree that I desire to say a few words. Following up what he has said, I am strongly of opinion that in the construction of military railways, the possible curves and gradients are the conditions which should technically govern its construction. Given an engine capable of working on sharp curves and steep gradients, it will be found in every way better in a military point of view to construct the railway on the natural ground when possible.

I do not say that circumstances may not arise in which a railway of the construction illustrated by the diagrams and explained by Captain Luard might not be useful. If railways of that construction were largely used in this or any other country for civil purposes, and means were thereby at hand for providing plant of the special construction and character required, I do not say that it might not in certain exceptional cases be expedient to make use of such plant, and construct a railway of that character; but so far as our experience of military railways has yet gone, I do not believe the case has arisen in which it would have been desirable to adopt a railway of such a special construction. It certainly did not arise in the Crimea, and I do not believe it arose in Abyssinia.

Referring to Abyssinia, there is one point to which I desire to call attention. Lieutenant Willans has stated that the general inclination of the ground, along which the railway was made, was 1 in 40. The engineering difficulties of that line arose from having to adapt to that slope a gradient of 1 in 60, so as to take the rolling stock sent out from Bombay to work that line. The engines weighed 16 to 20 tons, and they were not adapted for working up a steeper gradient than 1 in 60. Had an engine capable of working up a gradient of 1 in 40 been available, the engineering of that line would not have been so difficult, and the time required for its construction would not have been so long.

Captain Luard omitted to quote from Lieutenant Willans' account of that railway, the fact that 40 yards of rails were laid per hour, or 400 a day with the light 40 lb. rails, and 250 with the heavy 65 lb. rails. In my small endeavours to carry on plate-laying with soldiers, I have not succeeded in arriving at that rate yet, that is, working from one end of the line to the front. I do not know whether it has been arrived at at Aldershot. Perhaps Captain Luard will say whether it has, but, if it has, I consider it satisfactory. I doubt whether that rate of progress would be exceeded with the trestle construction, because when Mr. Fell states that he can do a mile a day, I think he says he works from several points along the line. He says, "A section having been taken over the ground, and the heights of the rails "above the surface ascertained, the materials would be distributed along the line, "suitable supports having been selected from the assorted lengths sent out from "England." In order to get the special plant selected and laid out along the site of the railway, you would have to provide some means of storage and transport in the first instance, and this is easier said than done.

I do not myself believe we could arrive at so great a rate of progress as Captain Luard assumes.

It may be interesting to know that the War Department is at this moment constructing a line of tramway, four and a half miles long,—which has been entrusted to the School of Military Engineering to carry out,—by partly trained sappers and by entirely untrained infantry soldiers, the working parties varying every day as they would on service. We are using 36-pound rails, and sleepers; the ruling gradient is 1 in 28 for a temporary line, and for the permanent line 1 in 40. The sharpest curve is 1½ chains. The rise in the first mile of line is 130 feet. The small engine we use is simply a traction engine, adapted at a small cost to be run on rails. The tractive power of the engine confirms what Mr. Grover has said. The weight of the engine is about 6½ tons. In dry weather that engine will draw 13 tons up a gradient of 1 in 28, and it will draw eight tons up 1 in 14. Its powers at 1 in 40 I have not yet tested.

I think we cannot but be grateful to Captain Luard and to the Chairman for urging the necessity of the formation of a military railway corps. I can only say that the question of the technical instruction of the engineer troops in railway matters has not been lost sight of in the School of Military Engineering. A small proportion of the limited time allotted for training the junior Officers and recruits, has for some years past been devoted to instruction in plate-laying, bridging for railways, &c., and within the last year the plant for the purpose has been largely increased. Unfortunately, we have, as yet, no authority to devote a lengthened period of time to the training of engineer soldiers in the technical duties connected with the construction of railways, but if about one-sixth of the total number of engineer recruits (which is about 450 a year) were put through a special course of instruction in this branch, we should arrive before long at the nucleus of an efficient railway corps. By training 75 men (*i.e.*, a peace company) per annum, we should very soon, without any expenditure worth speaking of, create an efficient nucleus of a railway corps.

For the subsequent practice of these men, there is an ample field on the State railways in India. The working of these railways would afford employment for for any number of trained soldiers; and if the question was urged on the Indian Government, I have reason to believe the engineer authorities who are charged with the administration of the Indian State railways would be only too glad to see an organized military body largely employed in the working of these railways.

The lecturer has treated the general question under three heads:—1. The

transport of troops on civil railways; 2. The repair, demolition, and restoration of such railways in time of war; 3. The construction of the small military railways I have been speaking about.

1. With regard to the use and management of the civil railways in England for the removal of troops, that of course is a question into which the civil element must very largely enter. The railway authorities and the railway engineers have shown a disposition to act in accord with the military authorities, by forming themselves into an engineer and railway transport volunteer corps, and I apprehend there would be no difficulty in bringing about such an understanding between the War Department and the railway authorities as would, at a small cost, materially enhance the value of our railways for military purposes.

There is a way in which the organization and military value of the railways might be improved that has been already suggested.* It is this. I believe the great grievance amongst the subordinate employés of railway companies is the want of pension on retirement in old age. I have been given to understand, by railway officials, that many men are kept in the railway service for a period of life beyond which they are thoroughly efficient, merely because their immediate superiors did not find it in their hearts to turn them adrift without pensions after having served the companies faithfully for a large number of years. I believe it would be a very great boon to both the employés and officials in charge of lines of railways in England, if we could introduce a system of army reserve with respect to railway employés, that is to say, induce men who have a fitness for that employment, to engage for limited military service, and train them with the Royal Engineers—I say "Royal Engineers," because they are generally men of the class set apart in other countries for engineer soldiers, and such as we enlist. After a short period of service let these men go into the service of railway companies, and let their future liability to military service entitle them to a pension after serving a certain number of years on the railways—say when they arrive at fifty years of age, or some such period. In that way we might have a hold over a large number of railway employés in this country for a long period of years and at a small cost. These men, assisted by the gangers and packers of the railway lines, and under the command of engineer Officers, with whom would be associated the technical officials of the railway companies, would form the basis of an efficient railway or engineer militia.

We have artillery militia and infantry militia, but we have no engineer militia. I would raise the engineer militia from the railway employés, and their locality should be the railways of the country. By some such arrangement we might develope the civil railway organization of this country, which is unparalleled in its efficacy, so as to meet the requirements of the 1st and 2nd heads of the paper read. With regard to the minor question of field railways, I strongly feel, with Mr. Grover, that what we have to do is to adopt steep gradients and sharp curves, and stick to the ground and not attempt any artificial constructions.†

The Barlow rails, referred to by Mr. Grover, were very largely employed in a very interesting operation which took place last year, namely, the conversion of gauge of the Great Western Railway. The advantages of organization were manifested more clearly in that than in anything I can bring tangibly before you. The Great Western Railway from Swindon to Milford had to be converted from broad to narrow gauge, the engineers estimating it would take them six weeks to do the work. They commenced on the 1st of May the first section from Milford to Gloucester, I think about 170 miles in length. They had about 2,000 men employed to carry it out. The actual alteration of gauge was done in about fourteen working days. Then a smaller section was taken in hand, about 36 miles, with a proportionate number of men, but men who had been previously trained and exercised on the larger portion. Exactly the same kind of work had to be done with about

* See "R.E. Journal," for April and May, 1873.

† A strong objection to these constructions, which was not urged at the meeting, is that they do not afford the same facilities for crossing the line, as railways laid on ordinary sleepers, and thereby are liable to impede military movements across the line of railway.—A. L.

the same proportion of men, and what took fourteen days to do in the first case, was done in less than four days in the second.

Mr. FELL: If you will allow me to make a very few remarks on the observations of Mr. Grover, I shall be glad to do so, for the purpose of showing the use of the centre rail arrangement, which has been referred to by Captain Luard. My experience has differed considerably from that of Mr. Grover. I congratulate Mr. Grover on the easy character of the 400 miles of railway he had to survey last year. The railways I have lately been called upon to examine and prepare designs for, were of a very different character, and required some exceptional method of working and construction. Now it is perfectly possible to adopt the plan under certain circumstances that Mr. Grover alludes to, where the natural formation of the ground is too steep to enable an engine to draw a load over it, and you would make the line, which would otherwise be only 10 miles in length, 30 miles in length. You would, by making the line 30 miles in length, with an ordinary engine, carry the same load that with the centre rail engine you could carry over the 10 miles. Now, for military purposes, I fancy there would be a saving of time, and, for commercial purposes, a saving of money, if you made the 10 miles and not the 30 miles. Not only would there be a saving, supposing the works in both cases are of the same character, of two-thirds of the cost, but you must recollect that these mountain passes, where you require the steep gradients, are generally so narrow that there is no room to develop the line except at an enormous expense. My attention was first called to the necessity of adopting something more than the adhesion given by the weight of the engine in the valley of the Ombrone, where the Austrian and Italian Governments were desiring to make a railway from Pistaja to Bologna, reaching up to the summit at Pracchia. The natural inclination was an average gradient of 1 in 20, but they wished to give to the railway a gradient of 1 in 40. In order to do so, it was necessary to develop the line over very difficult ground, passing through tunnels and over valleys with heavy viaducts, so that while a surface line could have been made over the 10 miles at 20,000*l.* a-mile, the railway was made 40 miles long at a cost of 40,000*l.* a-mile. Consequently that railway cost four times as much, and was twice as long as it need have been, if the centre rail system had been used. Therefore, in such a case, the centre rail principle would have had a very considerable value and advantage over the ordinary system in the saving of time and money. The cost of the Mont Cenis Tunnel Railway was ten times greater than that of the centre rail summit line, and with such an excess of expenditure, it cannot be considered as a commercial undertaking, for it will never pay interest on the capital employed, but it was made for political purposes as a national work by the two Governments. In the case of tunnelling through a mountain there is some compensation for the expenditure, in this way, that there is a great saving in the height to which the traffic has to be elevated, and therefore there is a saving in the working expenses. If you have to gain a certain elevation, say 4,000 feet, in ten miles, you require only the same power as if you took a distance thirty miles to do it; there would be no extra quantity or cost of power required; you double or treble the power for the time being; but then the time employed is less, and the distance being proportionably less, the cost of the tractive power employed is no greater for the centre rail line than for the other. There is therefore a saving in adopting the shorter route; and I think that under these special circumstances, in mountainous districts, the centre rail arrangement will be found to be extremely economical. With regard to Colonel Leahy's remark, that it would be better to stick to the ground, by all means, where practicable, do so; but there are some circumstances when it is absolutely impossible to follow the ground line, for if you do, your engines and trains will stick at the bottom of the hill. At Aldershot, the line Captain Leahy has described, passes over a viaduct 20 feet in height. Supposing you were to adopt Colonel Leahy's plan, you would then have a gradient of 1 in 5 to ascend, but having made your railway over 1 in 5, you could not have got the engine and tender alone up such an incline; you must therefore necessarily have works of some kind. If you could select the ground for war in some place where there would be no works required, and where the ground would not have an unevenness of more than 1 in 30, you would require no other railways than those Colonel Leahy recommends; but if you have ground where works are indispensable, you

must have cuttings and embankments, or their equivalents; and if you have cuttings and embankments in a railway that requires to be made with expedition, even if those cuttings and embankments are perfectly easy, you cannot make them in less time than you would make an ordinary railway. Therefore, the war might be finished, and the battle lost, so far as it depended on the rapidity of the transport of supplies, before you were able to get your improved means of transport brought into operation. If you require to have works of any kind, the question is what description of works could be most easily executed. I have considered that matter with many practical men, and have not been able to find anything so well adapted as a structure something similar to that which is made at Aldershot. It might be constructed of wood or of iron, the work being executed before the commencement of the railway, and a certain quantity always kept in stock. This kind of structure, as far as our present knowledge goes, can be erected with greater rapidity than any other method employed for constructing railways, and, as Captain Luard observes, time is the most important element in all the operations of war. If Colonel Leahy will make a certain length of line with earthworks, and let me make a similar one with the Aldershot form of structure, and the same number of men, we then shall see which can be completed first.

Colonel Leahy: I am willing to accept that challenge, to survey and execute the railway in the same time, over the same ground; and with a smaller proportion of "skilled" labour. There is no reason why trestles should not be used with the ordinary gauge as well as with the railway of the special construction adopted at Aldershot, but if possible, their use should be avoided by employing a larger number of unskilled workmen on earthworks.

Mr. Grover: Mr. Fell objected to this gradient, because it was 1 in 20, and stated, I think, that the Austrian Government were not able to get their engines up. I would merely mention that on the Taff Vale Railway, there are engines working every day over a gradient of 1 in 18½, and that on a Mexican line they are now working up a gradient of 1 in 25, 13 miles on end with the Fairlie engine.

Captain Luard: I have very little to say in reply, because the objections taken have been answered by the various gentlemen who have been speaking. Colonel Leahy stated that in his opinion the length of railway made in Abyssinia per diem was as great a length as could reasonably be anticipated to be made in any one day. (Colonel Leahy: Working from one point.) The number of men employed in making 400 yards of line per diem with light rails, or 250 yards with heavy rails, was 268, but there is no reason why the number of men should be limited to 268. You may employ a far greater number of men even starting from one point. I cannot admit at all that 400 yards is the limit that you can make in one day, nor can I see any reason why you should limit yourself to working from one point of the line. At Metz the Germans had 300 waggons available for their railway work, and they started from various points, and practically one would always make every endeavour in constructing a railway, to start from as many points as possible. Therefore I do not see that there is any necessity for fixing 400 yards as the limit to be done in a day. If you can transport the materials for a line of railway to a certain number of points, I assert that you can construct ten miles of railway in the course of a day. Colonel Leahy has not attempted to disprove that with a sufficient amount of transport, ten miles of railway could not be constructed in the course of a day. I have shown that a railway could be made to transport without any difficulty the total weight of structure for one day's line, that is to say ten miles, and if transport could be provided at the terminus of that line to distribute the materials for the next day's work, it could be done. I do not quite understand what object there would be in establishing the nucleus of a railway corps in India; though it would be of some advantage to India, it would not be of much advantage to Great Britain. We never know when the moment may arrive when we shall want the railway corps, and I do not think India is the place to establish it. With regard to the gradients more especially in India and Central Asia, I think you would find many cases would occur in which at least a gradient of 1 in 20 would have to be encountered. In a country so irregular as Central Asia, where it is possible we may have some day to construct railways, I do not think you could depend upon it that 1 in 30 would be the ruling gradient that you would have to work over.

Lieutenant-Colonel STRANGE, F.R.S.: I should like to ask the lecturer if he would give us his opinion as to the relative cost of maintenance. We have not considered the subject of maintaining these lines. I think myself it is a very important part of the matter, and I think Mr. Fell's system presents certain facilities with regard to it.

Captain LUARD: The cost of maintenance is not a question I have anticipated at all. It is not expected that a field railway will be required to last beyond a limited period, and if it is made sufficiently well in the first instance, I anticipate it will last out the time required for the purposes of a campaign.

The CHAIRMAN: I will not protract the discussion, but I have much pleasure in conveying your thanks to Captain Luard for his valuable paper.

Evening Meeting.

Monday, June 16th, 1873.

The SECRETARY of the INSTITUTION in the Chair.

NAMES of MEMBERS who joined the Institution between the 10th and 16th June, 1873.

LIFE.

Pemberton, S. E., Capt. R.A.

ANNUAL.

Duncan, A. W., Capt. R.A.
Arkwright, F. W., Lieut. Coldstream Guards.
Mackean, Kenneth, Lieut. R.E.
Fitzroy, A. W. M., Lieut. Coldstream Guards.

ON IMPROVED LIFE-BUOYS, AND A SYSTEM OF DECK-RAFTS FOR SAVING LIFE AT SEA.

By MARK HAMILTON, B.A., M.D., Surgeon R.N.

I DESIRE to occupy your attention for a brief space this evening with some appliances for saving life at sea. I trust my subject will not seem tame in comparison with those to which we have been so much accustomed in this room. Perhaps I should have a better chance of commanding your interests if I were bringing forward some tremendous implement of destruction, or even if I could offer food for your intellectual capacities, and delight you with some of those beautiful and complex mechanical inventions or ingenious scientific discoveries such as we have heard here from a Bessemer or a Froude. Still, I am encouraged by remembering that such a subject as this is sure to commend itself at any time to an assembly of Englishmen, whose characteristic it is, that "nothing human is alien to them;" at this time especially, after a winter of unexampled severity—unparalleled for the suddenness and extent of the disasters at sea on our own shores—our hearts deeply stirred at the time, and when every one is asking, "can nothing be done to mitigate, if not to prevent these terrible disasters;" and although much has been done, I think I can show you that much still can be accomplished in the same benevolent direction. Terrible as is the picture of human life lost at home, shown every year in the Wreck Chart, I believe we have no idea of the number of poor fellows who are lost at sea, of whom no one takes account, of whom the only record is a word or two in the log "lost overboard!" When men in the merchant service fall overboard, which they often do from the defective condition of the gear aloft, old and worn out, and kept too long in use through

motives of economy, I believe the chance of their ever being heard of again is extremely small. The difficulty of getting their boats out in a seaway, short-handed as they usually are, and the short time, if any, in which the unfortunate man remains in sight, generally decide the captain to leave him to his fate, without an effort to save him. Then the sort of thing which is supplied to them in the shape of life-buoys is generally most inefficient, altogether incapable of sustaining them in the water any length of time, even if they succeed in seeing and reaching it, and in warm climates, escape the attacks of sharks. Some experiments were carried out two or three years since by Mr. James Greenwood,—then well known as the "Amateur Casual," from his personal investigations into the state of our casual wards—on these life-buoys, purchased at random from the slop-sellers at the east end of London. They are supposed to be made of cork, but were found to be composed of any other material, shavings, rushes, oakum, straw, or any thing to fill up the space, their floating power was therefore soon exhausted. Of three specimens on which he experimented, and which cost from 4 to 6 shillings each, No. 1 was marked "warranted corkwood." On a weight of 10 pounds being attached, it sank in an hour, proving it to be composed of straw. No. 2, marked simply "warranted," swam for 2 hours; it was stuffed with rushes. No. 3, marked "all cork," floated for 4 hours; it consisted of cork chips outside, about 20 per cent. of the bulk, the rest, rushes and shavings. These ring-buoys are also supplied by contract to Her Majesty's ships, but whether any steps have ever been taken to test their efficiency I know not. A question was lately asked in the enquiry into the loss of the "Northfleet," how it happened that no one was found clinging to any of the life-buoys known to have been on board. Perhaps these investigations may serve to supply an answer.

I would now speak of the life-buoy so well known to every one in Her Majesty's service. It is the invention of Lieutenant Cook, so long back as 1811; since which time I may say, little or nothing has been done to improve it. I do not think there is any one, who has had any experience of it, who will not be found to condemn it. Indeed I have often heard it asserted, that more lives have been lost through it, than saved. It is rather a painful reflection to think that so much has been done by human ingenuity in the means of destroying human life, and so little in saving it. In the Committee which assembled at the Admiralty last year to investigate the subject of lowering gear and life boats, the enquiry—thanks to the energy of Mr. Bouverie—was extended to life-buoys. The testimony of nearly every witness agreed in condemning the service buoy as useless and dangerous; some going so far as to say it was more calculated to drown men than to save them. The lightest judgment passed on it was, that it needed much improvement. I am pretty sure the experience of every naval Officer who hears me, is in accordance with that testimony; and I may mention here in passing, that the only life-buoy that received any commendation, was the one I now show you. Several witnesses who had seen it tried, some who had had it fitted to the ships which they commanded, spoke highly of its practical merits; yet the Com-

mittee had not a model of it even before them, and an application from the inventors to attend and explain its principle, was not entertained.

Well, Sir, that Committee issued their Report, and gave us their ideas of what an efficient life-buoy ought to be, but I regret to say they did not ascertain for themselves whether there was not in existence a buoy fulfilling more than their own requirements. The Committee laid down, that an efficient life-buoy should be capable of sustaining a man in the water without effort on his part; secondly, that the light on a buoy for use at night, should be so placed, as that the sparks or flame should not fall on the man swimming to it, and thirdly, that the light ought to burn at least twenty minutes. These, in their opinion, are the conditions of a good life-buoy. It is easy, I think, to show that many qualities just as necessary have been omitted. One property, valuable above all others is, that of discernibility: the life-buoy should be visible as long, and as far off as possible; it should be easy of access; it should afford protection from attacks of sharks; and if possible, have a supply of fresh water, the most valuable aid in recovering a man stunned by the shock of sudden immersion, and the struggle for life he perhaps had, before reaching the life-buoy. Now, I ask how many of these properties does the life-buoy, so long, and now almost universally supplied to Her Majesty's ships, possess? I think I can confidently say not one, yet these are the implements which the Committee pronounce "the best generally known." With regard to the property of discernibility in a life-buoy, I would for a moment recall to your recollection the sad accident last year to the boats of the "Ariadne;" an event which caused such a painful emotion in this country. It will serve to illustrate the vital importance of making a life-buoy as discernible as possible. When the unfortunate man first fell overboard, the buoy was of course instantly sent after him, so that even if he never reached it, it could not have been far from the place where he fell; yet the crew of the boat sent to pick him up, declared, that they had never seen either the man or the life-buoy, proving that they never could have been near the place where he fell, and of course had no chance of saving him, as they did not know whither to pull to seek him; whilst perhaps the unhappy man might have been clinging to the buoy, and watching with straining eyes the boat pulling in every direction but the right one, until it capsized, that is, if his strength enabled him to hold on. Now, had there been an efficient life-buoy in this instance, capable of being seen at a distance and efficient in other respects, the boat would have known whither to pull, the man most probably would have been saved, and when the boat capsized, there would have been an implement at hand capable of sustaining at least as many men as perished. It was this accident to the boats of the "Ariadne" which led to the appointment of the Committee. In the course of their enquiries into this branch of their subject, many excellent suggestions were thrown out, such as the immense advantage of having a life-buoy, which being known to be efficient, and capable of sustaining the men until help arrived, and even longer, would relieve the mind of the Commanding Officer from pressing anxiety as to the man's immediate

safety; he could then so much more leisurely and calmly see to the deliberate and careful lowering of the boat without risking the lives of the crew by undue hurry as is now often the case. But after all, let me ask to what practical result have the labours of the Committee tended? So far as I can see, I am at a loss to discover. Have we had, or are we likely to have any practical test or trial or means of discovering which of all these appliances is the best for the public service? A short time before the present Board of Admiralty came into office, a series of experiments were ordered to be instituted at Sheerness and Portsmouth on the life-buoys then known. They were thoroughly carried out by Admirals Sir Jas. Hope and the present Sir Astley Cooper Key, in the presence of a large number of Officers; but from that day to this, nothing has been done to act upon those experiments and reports; and though this buoy, which I show you, was highly commended, no steps have even been taken to supply it, or, if possible, a better one, to the service generally.

A few have been fitted to the Indian troop-ships; and at the last moment, on the urgent request of Captain Nares, one was supplied to the "Challenger." A distinguished Officer lately called from the Council Board of this Institution to a position of high command, one whose absence from amongst us for a time we shall all regret, about to take his ship to the antipodes, applied, I understand, several weeks since, to have her fitted with one of these life-buoys, but only at the last moment,—and I believe too late to have it made and fitted,—was the order given. Some of you will remember a similar story told by Mr. Lacon in this room of Hill's lowering gear being ordered for the "Challenger" when on the point of sailing; and there being no time to fit it properly—she lost a boat in a gale in the Channel.

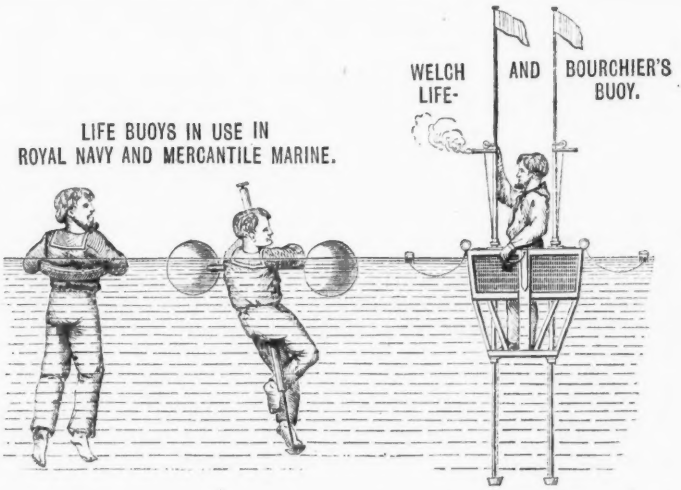
At an exhibition lately held at the London Tavern in connection with the "Northfleet" fund, an immense number of appliances were exhibited for saving life at sea, and amongst them, a vast amount of ingenuity was displayed, and no small interest was manifested by the public at the time; but I regret to think that no practical result has followed or seems likely to follow. As one of the Council of the Institution, who was chosen to pass judgment on them, sensibly remarked, "Nothing can be really known of their practical merits until they are "practically tested," and that I fear is a consummation exceedingly remote. Here is again another instance of wasted energy. As a nation we seem to be sadly unpractical—our feelings effervesce; the occasion passes away, and leaves behind nothing but a residuum, "flat, stale, "and unprofitable." Would not the proper thing, after such an exhibition as that, be, to have a practical trial by, say the Board of Trade on behalf of the mercantile marine, and by the Admiralty on the part of the public service, and find out what are the best practical appliances, and having found them out, adopt them into the Royal Navy, and insist on their being adopted into the merchant service? I know as a fact that more than one kind of life-buoy has been brought to the notice of the present Board of Admiralty, but with what result? The last time I was at Spithead I saw hanging at the quarter of the "Bellerophon" a modification of the old service

buoy, with certain improvements, no doubt, some of them copied from this buoy. It is, I believe, the invention of a carpenter in the service, and in the "Liverpool" took a voyage round the world in the Flying Squadron, but what is its practical value? Has it been tried or reported on, or is it going to be adopted? Has it been tested in competition with any others?

I am not here to sound the praises or unduly to exalt the merits of any particular invention—but I would impress most earnestly on the minds of you, gentlemen, who are members of this Institution—some of you who are, and some who may be at any moment called to the administration of our naval affairs, or to hoist your flags in command of our fleets, or be appointed to commission our ships—to look to this serious defect in the equipment of the ships in which we serve. Do try and use your influence to have that antiquated, obsolete, useless, nay dangerous, implement misnamed a life-buoy—ought to be called a death-buoy—utterly abolished out of the service, and something really calculated to save life, adopted in its room. It is no defence of it to say, as one or two witnesses have said here, that they have seen men saved by it; the same might be said of an oar, a hencoop, or a spar; but will they trust to such things in the hour of peril, or are we justified in providing nothing better for the rescuing of men and Officers who suddenly find themselves overboard? I am afraid we owe to the comparative rarity of the accident of men falling overboard—due to the nerve and skill, agility and discipline which distinguish our seamen—that for so many years nothing has been done to improve the service buoy. But happily we live in times remarkable for a vastly increased appreciation of the value of human life, and for a chivalrous heroism ever impelling men to dare the rescue of others' lives at the hazard of their own. Do we ever hear in these days of a man falling overboard without also hearing that one, two, or three men or Officers have sprung instantly to rescue him, hardly waiting to divest themselves of the clothes that add so much to their danger? Surely it is incumbent on us to aid by all means in our power such gallantry and devotion. Let us reflect, moreover, a little on what is likely to happen in future wars carried on at sea. How is human life most likely to be destroyed? I venture to say not chiefly by shot or shell, not by cutlass or pistol, but by drowning. Our guns are few, if tremendous; the action will be ended one way or the other before many shots have been fired, or suddenly, by ramming, or torpedo. Are we not bound, then, to devote our attention and ingenuity to devise the best means of saving life from drowning? I should feel very proud if I thought that our meeting here to-night would do something to promote that end before we find ourselves engaged in a war in which everything will be as new to us as if we had never been at war before, in which we shall have everything to learn, and in which it will be well for us, if the indomitable pluck and nautical skill of our seamen be not overborne by the irresistible might of scientific invention.

The life-buoy, of which this is a model, consists of an air-tight, oval, thin metal casing, about 16 inches deep and 6 inches across, forming a double cylinder, and having a central space of 18 inches by

16, open from top to bottom for the reception of the person or valuables to be saved. The interior of this casing is divided into two



parts by a partition of metal, which is about 14 inches from the top, giving a capacity of about $3\frac{1}{2}$ cubic feet, and leaves a space of 2 inches, which is to be kept as a reservoir for fresh water to be used by the person saved in the event of his being compelled to remain adrift from his ship by reason of bad weather, fog, &c. This water space has two tubes leading to the top of the buoy, which are fitted with india-rubber nozzles or mouth-pieces.

The air-tight casing or floating power is sheathed or covered with wood battens, tongued together to afford protection against the stem of a boat or boat-hook used in picking up the buoy, also to prevent the metal being bulged, if it strikes the side of the ship in hoisting. This casing, which may be made in one or more compartments, and of any suitable metal, is enclosed in an open framework of iron or steel, connected by rivets, having a grating or small platform at the bottom, on which the man stands; this grating is about 3 feet from the top of the buoy, thereby leaving a man's vital organs (to use a popular term) out of the water. This apparatus is further provided with two stationary hollow tubes or sockets, about $1\frac{3}{4}$ inches in diameter, passing from top to bottom, each containing a signal staff for the purpose of indicating the position of the buoy to the man in the water, to the boat sent to rescue him, or to attract the notice of a passing vessel. Each signal staff is telescopic, being formed in two or more parts or sections, fitting the one in the other, the whole being contained in the stationary sockets before mentioned. The signal staff is automatically

raised out of its socket, on the buoy being "let go" by means of a weighted rod sliding in the stationary socket. To the telescopic mast or staff are also attached port fires or fuzes, to serve as signal lights, one being ignited by the action of "letting go," while the other is at the service of the man in the buoy to show his position at night. The first or port fire section of the signal staff is raised out of the socket by means of chain or copper wire rope, one end of which is secured to the lower end of the weighted or ballast rods, and passing over a sheave fitted to upper part of stationary tube is attached to lower part of port fire section, working in a slot or groove cut in the stationary tube. The upper or flag section of the signal staff is raised in a similar manner. one end of the cord being secured to the upper end of stationary tube, and passing over a sheave fitted in upper part of first or port-fire section is attached to lower end of flag section. The flag attached to this section or table is nearly 7 feet from the water. The upper part of the buoy floats 6 inches, and when a man is in it, about $2\frac{1}{2}$ out of the water; the outside ledge of the buoy, made of an oval shape, is about 32 inches by 30, and 34 inches deep, tapering from 16 inches, the depth of casing; the interior 18 by 16, masts above water 5 feet; weight of whole about 130 lbs.; the platform or grating is about 16 by 15 inches. The arrangement for suspending and letting go this apparatus, which may be hoisted by any suitable tackle, one extremely simple, consists of two hollow tubes as davits, projecting horizontally from the ship's stern or quarter, or under the bridge end. A sliding bolt in each davit taken into an eye or loop on the sides of the buoy next the telescopic masts being received into a slot on the under side of the davits, which is thus securely attached. A cap is fitted to rods between the davits above each signal staff, to prevent the latter rising into position, when the buoy is suspended at the davit. The buoy is detached by withdrawing the bolts before mentioned, which are connected on board by a bar, having a hook in the centre, over which the trigger line for firing the fuze is looped, thus the action of firing and "letting go" simultaneous. If the port fire is not to be ignited, the trigger line is detached from the hook previous to letting go the buoy, the line remaining pendant from the port fire-pan, so that the means of igniting the same always remains at the command of the person in the buoy. There has been lately brought to our notice in this Institution the self-igniting signal of Mr. Holmes, which seems an invention admirably suited for life-buoys at night. It is inextinguishable, burning on the surface any length of time, thus fulfilling two of the requirements of the Committee, viz., avoiding sparks and fire on the man's face, and burning a sufficient time. It made a brilliant show on the Serpentine, in the exhibition of "night-signals" of the "Northfleet" Committee. It seems the best thing yet discovered for the purpose, and it is proposed to adapt it to this buoy. Corks or other floats are attached to the upper rim of the iron frame-work of the buoy, with bights of rope to catch at, so as to sustain a number of men hanging on. In pointing out the advantages of this buoy, it may be noticed, that it is capable of sustaining a boat's crew, by holding on to the floats and bights, that it carries fresh water enough to sustain life for days should the man be lost sight of, or the

weather be too bad to pick him up, that in the event of a man in the buoy losing his ship altogether, it affords great additional chance of saving his life, from the facts of his having water to drink, signal-fire at night, and signal-flags by day, nearly 7 feet high, always flying so as to attract passing ships; it affords complete protection from sharks; it can be hoisted up with a man in it, without having to lower a boat or send men outside the ship; and that in the case of the total loss of the ship, all ship's papers, chronometers, and other valuables might be stowed in it, certain of being eventually picked up by some passing ship.

The life-rafts (of which I regret I am unable to bring before you a model this evening), though perhaps not always applicable to men-of-war, ought to be of vital importance to merchant and passenger ships; in fact, it ought to be enacted by the Board of Trade that no such ship should sail without some such appliance. It is proposed to fit the skylights, deck-seats, bridges, or roofs of deck-houses with air-tight compartments, somewhat similar in construction to the life-buoy; and by a simple arrangement of chains and spring hooks, to connect them together, and thus make one large and safe raft. Each compartment of this raft may have a supply of fresh water always available, and if fitted with telescopic masts, will have signal fires to use at night, and signal-flags by day. It will be observed that no preparation is required to connect these seats and skylights into a raft, the masts and water-tanks being similar to those used in the life-buoys. To show how much space may be utilised without taking up more room than the ordinary seats and skylights, suppose the upper deck to be fitted with one skylight and four deck seats; the skylight is, say, 12 feet long and 6 feet wide, having an aperture 9 feet long and 3 feet wide, thus having the seats of skylight 18 inches high and 18 broad, then the four deck seats being 12 feet long, 18 inches wide, 18 high, will give altogether 175 cubic feet of enclosed air space and 144 square feet of standing or sitting room, more than sufficient for 50 persons. The lower part of aperture of skylight should be fitted with two broad flaps of large-meshed netting, so as not to exclude air or light when used as a skylight, and serve as a floor for standing on when floating in the water. These rafts always serving as necessary articles, might be made to take the place of those numerous and expensive lifeboats which merchant ships are now compelled to carry, but which are so seldom found available when wanting. Thanking you for the kind indulgence with which you have listened to me, I shall only add, "Si rectius isto novisti, can-" didus imperte, si non, hoc utere mecum."

Mr. HOLMES, electric engineer: As proprietor of the light that Dr. Hamilton has spoken of in connection with the life-buoy, I may be allowed to point out that one of the great values of the signal attached to a life-buoy is, that it shall be self-igniting and also inextinguishable. I do not think Dr. Hamilton quite explained that this signal when the buoy falls into the water, lights itself. If an ordinary life-buoy is thrown over on a dark night it is almost impossible for a drowning man to find it, and also it is impossible for the vessel to find the buoy and the man, even supposing he succeeds in reaching it. By having a signal which ignites in the act of falling into the water, you overcome one of the chief obstacles to the saving of life. I do not wish to enlarge on the merits of my new light, but at present it certainly does fulfil three very im-

portant conditions: it is inextinguishable in the water; it ignites on contact with the water; and it will continue burning fully one hour.

Captain CALVER, R.N.: Dr. Hamilton remarked on the possibility of hoisting this buoy up with a man in it, but I did not exactly understand from his description how the buoy is to get to the ship. I do not suppose the man in the buoy has the means of propelling it towards the ship; in fact, the ship, under sail, will have to pick up the buoy, which every seaman knows is a very awkward and nearly impossible thing to do. I have been 44 years in the naval service, continuously engaged, and have often seen the old life-buoy let go, and so far as my memory serves me, I never knew a man's life saved by it. There is one thing in the Doctor's life-buoy which is extremely meritorious, that is its visibility. Now, as a practical surveyor I have been usually in the habit of using floating objects, and I have had no difficulty whatever at a distance of five miles in reflecting a floating object in the water. If that be so, it is quite clear if the Doctor has any means of attaching tube flags to that buoy it will really be a most valuable addition. I cannot conceive anything more important than that. Without knowing of the failure of the upper mast, I should have ventured to predicate that. It would be difficult indeed for a buoy to go fairly into the water free of everything without damage to your upper or top mast. Therefore I should sooner see some flag attached to your lower section, which would be ready to be unfurled by the man when he gets to it. Then another great merit as compared with the old buoys is, that when once the man is in it, there is no need of any further personal exertion; that is a very important thing. The whole thing strikes me as being a most valuable improvement upon the buoy which I have been used to see during service at sea.

Dr. HAMILTON: You spoke of the man in the buoy getting into the ship. Supposing he is towed by the boat sent to pick him up, of course it is a great advantage that the man should be able to be hoisted up just as he is.

Captain CALVER: I understood you to say the buoy might be hoisted up without the necessity of lowering a boat; that is the point that struck me.

Dr. HAMILTON: The weather might be very bad, too bad to lower a boat; at the same time the ship might work up to where the man was in the buoy, and you must remember that in this buoy a man will be sustained for hours. That is a very important point to anyone who has had the experience of seeing a man trying to cling on to the old man-of-war's buoy when there is no sea on, for it is impossible to do it when there is a sea on. It is impossible that he can hold on to the buoy for any length of time, even in smooth water. But here is a buoy which will sustain a man for a very long time, and in the case of a merchant vessel which is short handed and cannot lower boats, the man might be in the buoy long enough for the ship to work up to him and pick him up without lowering the boat at all. With regard to the masts, of course the masts are an invaluable property of the buoy. The discernibility of this buoy and the utter impossibility of seeing the service buoy at any distance from the ship, are in strong contrast. The masts are most valuable. I quite approve of the idea of Captain Parkyn, H.M.S. "Crocodile," of adopting two light ash rods to carry small flags. Then as to the accessibility of the buoy, the man swims to it, he takes hold of the bights or the floats, and he gradually draws it to him, he cants it over and gets in, and, as I myself have seen in the experiments at Portsmouth and Sheerness, the ease with which the man gets in, is something wonderful.

Captain BOURCHIER, R.N.: I may say I have seen it myself with one man inside and eight men holding on with their chests above the water. As to getting into the buoy, to use the words of one man, it was just as easy as stepping into a carriage.

The CHAIRMAN: I am sure you will allow me to return your thanks to Dr. Hamilton for the excellent paper he has given us.

GRIFFITHS' PATENT BOW- AND STERN-SCREW STEAM-SHIP.

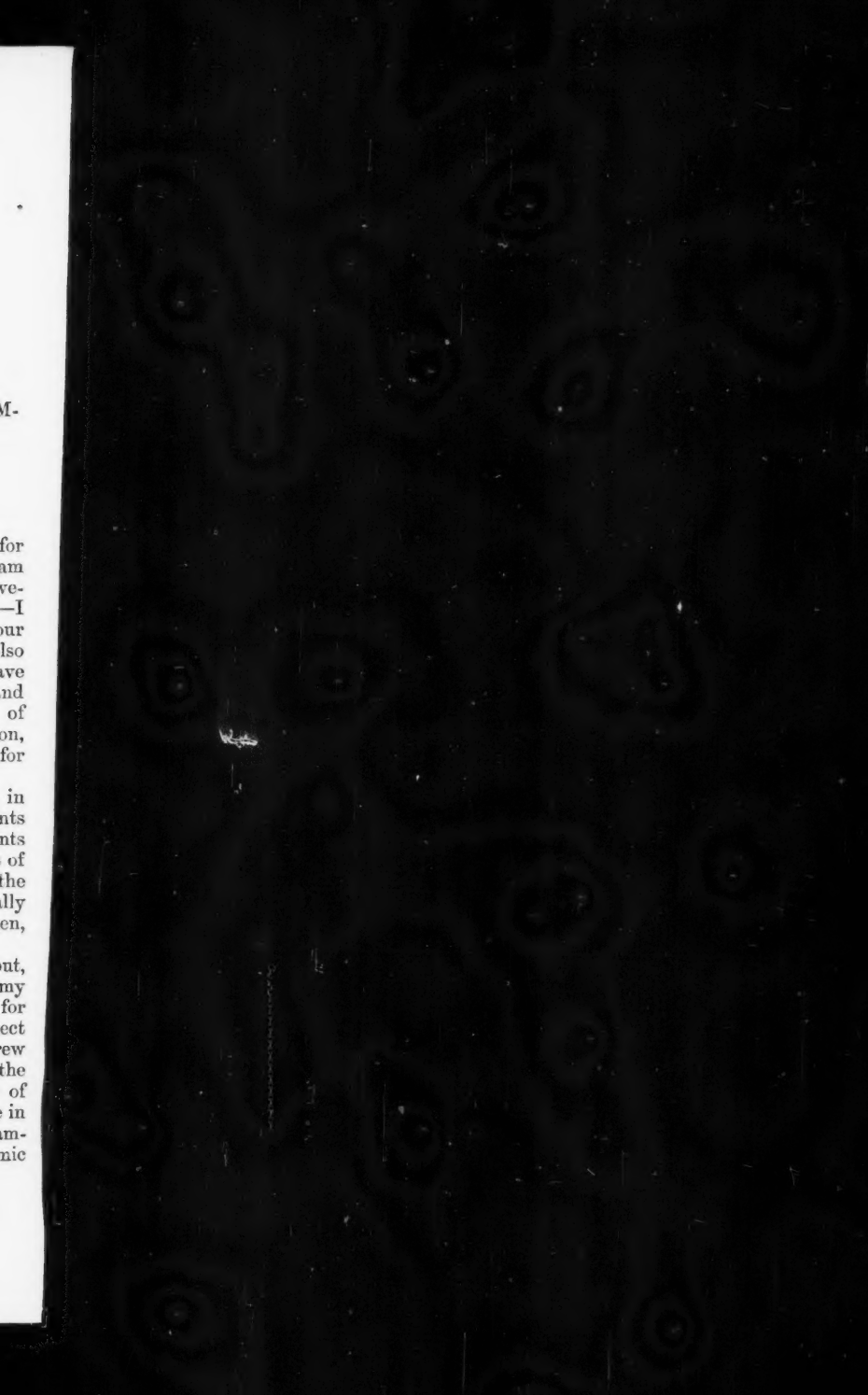
By R. Griffiths, Esq.*

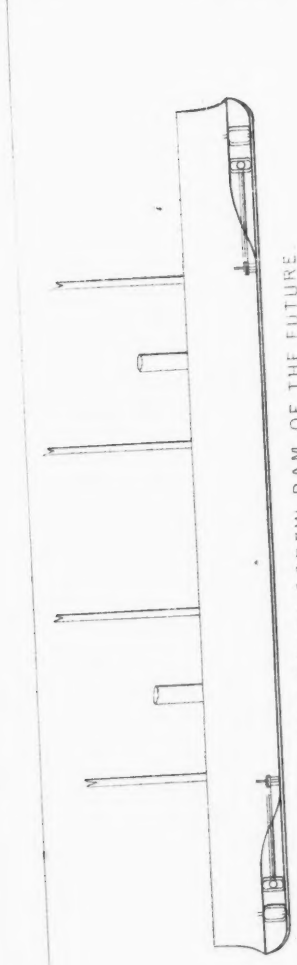
Having taken great interest in the propulsion of screw steam-ships for several years, and being fully alive to the vast importance of steam navigation both for war- and also for mercantile-ships,—to the improvement of which propulsion I have devoted a great deal of my life,—I trust that I shall be pardoned for occupying your time by calling your attention to a few practical suggestions that I wish to make, and also for bringing before you the results of a series of experiments which have occupied me for nearly two years, first upon working models, and latterly upon a small screw-steamer, the "Alpha," by means of which trials I have arrived at conclusions which will, in my opinion, form the basis of a new and improved system or arrangement for working screw steam-ships.

Since the introduction of my improvements in screw-propellers in the year 1849, there have been numbers of patents for improvements in screw-propellers; but the only one of these so-called improvements that has stood the test of time and practical working, has been that of the enlargement of the boss, and the making the blades narrow at the points and wide at the roots, in contradistinction to the plan generally used prior to that date, which plan was the reverse of that I both then, and since, have advocated.

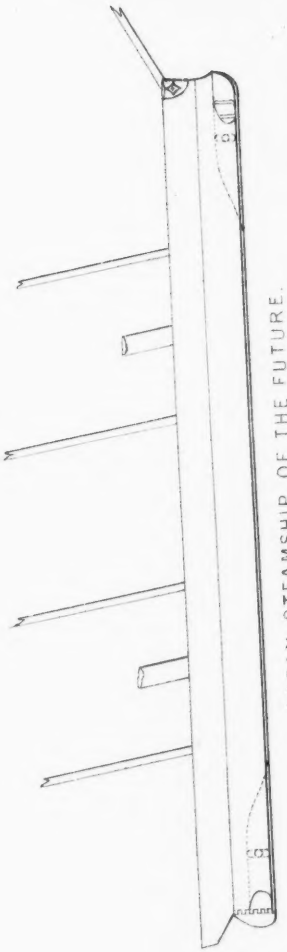
I have tried several alterations in the form of the screw without, however, obtaining any material improvement in the results, and my experience has led me to believe that no real good is to be looked for in the mere alteration of the form of the screw itself, that subject being exhausted; and that if any further advance is to be made in screw propulsion, it must be sought in the manner and position in which the screw is to be applied to the ship, or, in other words, the manner of applying the propeller to the object to be propelled; it being borne in mind that experience has shown that the greater the length of a steam-ship in proportion to her beam, the greater also are her economic advantages.

* Read at the Evening Meeting on Monday, June 16th, 1873.





BOW AND STERN SCREW RAM OF THE FUTURE.



OCEAN STEAMSHIP OF THE FUTURE.

J. Jobbins

Our own reason tells us, and the assertions of tried sailors confirm us in the opinion, that a vessel of 400 to 500 feet in length and 45 to 50 feet beam would be, should her engines break down in a heavy sea, a perfectly unmanageable mass, unless indeed such a vessel happened to have the advantage of a breeze, which, by means of her canvas, would give her a speed of about four knots an hour, or at any rate sufficient to obtain steerage way and cause her screw to revolve, and the probability is that, unless her canvas would give her that speed, she would get into the trough of a sea and would share the terrible fate of many large and first-class ships which have not been seen or heard of after leaving their port of departure.

In order to avoid some of the difficulties and dangers that now attend screw ships and also to improve their speed, it occurred to me that if, in addition to the screw at the stern, another propeller were applied in the bow of the ship,—both screws being placed in tunnels formed in the sides of the ship so as to be protected from coming in contact with such objects as a ship's anchor or cable,—it would be the means of avoiding a great many of the difficulties and dangers now attendant upon such ships.

In order to test the truth of my supposition, I had models prepared with strong clock-work springs to work the screws, in a manner similar to that which I employed when experimenting upon my first improvement in the screw-propeller.

Model No. 1 delivered the water on each side of the bow, and this bow-screw alone gave a result which, so far as speed is concerned, was as good as that obtained from the stern-screw worked in the ordinary way; and when reversed to drive the model astern, it showed a decided superiority over the stern-screw worked in the ordinary way.

I afterwards had made Model No. 2, which delivered the water from the bow-screw underneath the ship, and took in the water for the stern-screw from underneath, so that both ends of the ship were made the same below the water line; this I found to be the best arrangement, as the bow-screw itself gave a better result, in consequence of the water discharged from the screw meeting with a greater resistance, giving the same effect as is now produced by lowering the screw, and thereby obtaining a deeper immersion of the blades.

Another great advantage may be obtained by this method of placing the screw, and that is, that the screw may be made to discharge any bilge water or any great leakage that may happen to take place in the vessel.

This may be effected by having a discharge from the bilge to the forward edge of the screw in the stern-tunnel, when, by opening a sluice-cock or valve, the screw will draw its supply, or a portion of it, from the bilge, or the inside of the ship, instead of from the open stern, as shown in the drawings.

Model No. 3 is of the steam-ship "Alpha," as she was first constructed, but she was afterwards cut in two, and 8 feet added to her length, making her 50 feet long and 9 feet beam. On one side, are the tunnels as fitted, and the other side shows what she ought to be if my system

had been correctly carried out, which would no doubt have given a much better result than was actually given by the trials. This I have proved by my former experiments with models properly constructed.

Model No. 1 I first had made, with its discharge openings on the side of the ship, and No. 2 with the discharge openings underneath the ship.

A series of experiments with these models were conducted by Mr. Bevis, the manager of Messrs. Laird Brothers, in a trough 50 feet long, the boat being worked by the springs that are now in the model, and wound up the same number of turns for each run, the time being taken and the winding done by Mr. Bevis, which experiments gave the following results, taking an average of three runs :—

First three runs, with the screw at the bow in the open water, the time was 90 seconds and 511 revolutions of screw.

Second three runs, with the screw in the bow-tunnel, 71 seconds and 450 revolutions.

Third three runs, screw at the stern in the open water, on the old system, 80 seconds and 493 revolutions.

Fourth three runs, screw at the stern in the tunnel, 66 seconds and 430 revolutions. With one engine at the stern-screw and one engine at the bow-screw in the tunnels, it was 46 seconds and 416 revolutions.

The result of some trials made on the steam-ship "Alpha," at Lynn, on the 14th and 15th May last, showed that 160 revolutions per minute of the stern screw alone gave a mean speed in eight runs of 4·921, screw working in the tunnel.

160 revolutions per minute of the same screw gave a mean speed in eight runs of 4·626, screw working in the open water in the ordinary way.

160 revolutions of both bow- and stern-screw together, gave a mean speed in four runs of 5·820.

By cubing the speed of the runs with the screw working in the tunnel and in the open water, it gives 20 per cent. less power required by the screw when working in the tunnel to obtain the same speed as when working in the ordinary way.

The steamer "Alpha" is now at Lynn, and any persons that may desire to witness some trials made with her can do so by giving one or two days' notice to that effect; but such trials must be completed this week, as the owner is on the point of removing his vessel.

From the above facts, and trials that I have since made with the "Alpha," I can confidently assert that the advantages enumerated below will be found to exist over the present system of steam-ship propulsion.

1st. A considerable gain in speed or with reduced engine-power, the same speed is obtained as by the stern-screw alone, but with a considerable saving of fuel; a matter of vital importance at the present time.

2nd. Complete protection to the screws and rudders is insured by the tunnels, thereby avoiding the breakages of the exposed screws and rudders now frequently occurring in screw-ships.

3rd. In order to obtain the same propelling power as with the single screw, the bow- and stern-screws only require to be one-half the diameter of the single screw, and being fixed as low down as possible, the engines and screw shafts are more safely placed in the ship; the bow and stern-screw propellers being of smaller dimensions than in the single screw ship, smaller engines will be required, thereby effecting a great saving of weight and expense.

4th. There is no vibration from the action of the screw-propellers when working in the circular tunnels.

5th. A ship with bow- and stern-propellers can be stopped when going at full speed in less than one-half the time and distance that a ship can be with a stern-screw only. When the bow-screw is reversed the bow-rudder will act on the ship immediately, whereas in stopping and reversing the engines of ships with *stern-screws only*, the momentum will carry them in a straight line a considerable distance, owing to the stern-rudder not acting when the screw is stopped or reversed. The effect of this must be at once apparent, as in one case, not only is the speed reduced in less time, but the ship can be rapidly turned from her course, owing to the immediate action of the bow-rudder, while in the other case the ship proceeds in a straight line until the speed is checked by the action of the reversed screw or the exhaustion of her momentum.

6th. It will do away with the racing of the engines when in a heavy sea. With single-screw ships when the screw comes partially or wholly out of the water the engines get released from their work, so that without great care on the part of the engineers in checking the steam they are liable to become disabled; besides this, the ship loses its momentum, whereas by the proposed system the stern-screw cannot lose its water unless the stern and part of the keel are lifted out of the water, as the supply of water to the screw is taken from *underneath* the ship.

7th. By reversing the bow-screw the ship will stop while both screws are working, so that by the action of the bow- and stern-rudders, the ship will turn round on her centre either way without moving either backwards or forwards.

8th. Great safety will be ensured by working the bow- and stern-propellers with separate engines; for should either of the engines or screws get disabled, the other will be able to propel the ship at about four-fifths of her speed to the end of the voyage.

I believe that by applying engines and propellers in this manner at each end of a vessel, say of about 600 ft. in length, with 45 ft. beam, and allowing, say, 600 h.-p. for the stern-engines and 400 h.-p. for the bow-engines, an average speed of 400 knots per day might be obtained, and the passage between Liverpool and New York would be reduced to an average of from 7 to 8 days.

A ship with its machinery arranged on this plan, would work with comparatively little pitching in a heavy sea, because the weight of water in the screw-tunnel at the bow would prevent the bow from rising too suddenly, and when the bow is up and partially or completely out of the sea, the water would run out of the tunnel and lighten

the bow, so that it would dip more easily and not so deeply when going down again.

Another great advantage obtained by this arrangement, will be the additional cargo space gained along the centre of the vessel. The entire middle part of the ship will now be available for saloons and cabins, free from the unpleasant vibration caused by the engines and the screw-shaft, and be relieved from the disagreeable odours of the oil and tallow used for the machinery, and from the noise of emptying the ashes at night, &c., &c.

A ship constructed on this plan would not require above two-thirds the draught of water that is necessary for long narrow ships with a single screw. In any ship that requires 500 h.-p. or upwards with direct acting engines, the screw-propeller requires to be 20 feet diameter or upwards, and consequently the ship's draught of water will be 23 feet or upwards so as to get the screw well immersed; whereas with a screw at both ends of the ship, two 14-feet screws would give the same propelling surface as one of 20 feet, and would only require 16 or 17 feet draught of water. When screw-ships are in a heavy sea, the screw is often partially or wholly out of the water and has then no propelling power. In long heavy ships, one cause of their success arises from their momentum, which when once raised, any ordinary irregularity on the surface of the water is gone through without being felt, but when the sea is so rough as to cause the screw to be frequently out of the water, it materially retards the momentum of the ship; whereas when a ship has a screw at each end, when one of them is up and out of the water, the other is sure to be well immersed, and thus keep up the momentum of the ship, and her speed would not be retarded as in the other cases.

Captain HOSEASON, R.N.: Mr. Griffiths is a gentleman well known to us all as a great improver of the screw-propeller, and the present patent brought before us will, I conceive, lead to its nearly universal adoption, for it will greatly develop, I imagine, both the sailing and steaming qualities of all vessels to which it may be applied. Mr. Griffiths has directed our attention to the fact of the great and rapidly increasing length of steamers—formerly a length of only four times the beam was deemed sufficient, now 6, 7, 8, and even 12 times is required—this great increase of length, although most favourable to economy of power, *ergo*, fuel, has been found materially to prejudice the several vessels' steering qualities; great comparative length also has led to a great increase of the tonnage or size of all steamers, and with it, a demand for far larger screws, and this necessitates that steamers should be constructed with great draught of water—a very great disadvantage as a general rule. Mr. Griffiths claims, for his invention, eight advantages over the ordinary propeller, and I think he proves them clearly. But I believe that there is another advantage which he has entirely overlooked, viz., that his mode of applying his propellers will greatly facilitate the use of canvas whilst under steam. All steamers, either constructed with the screw or paddle, find it nearly impossible to carry after-sail when on a wind, from the tendency that they have to gripe, or fly up in the wind. Now I conceive that the power, as he proposes to apply it, divided between both extremities of the ship, may remedy this great defect, and will thus enable more canvas to be carried when under steam—this combined action of steam and sail leads to a great economy of fuel—for the wind costs nothing, and yet we increase its intensity over the area of the canvas, especially when the true wind is on the quarter or beam. If, for example, a steamer was sailing with the wind on the quarter with steering sails, &c., going 4 knots an hour under canvas alone—

you could easily accelerate this velocity to 8 or 9 knots, with the use of a very small portion of steam, considerably less than that two boilers produce out of four. This accelerated velocity to 8 or 9 knots would oblige the taking in of all the steering sails and the bracing sharp up, but the intensity of the pressure of the wind on the area of the remaining canvas would be increased greatly by the accelerated velocity of the vessel through the water, and is thus made to act as a stronger motive power. Unfortunately the tendency of all steamers to gripe, renders all after-sail under these conditions nearly unavailable, at least I found this to be the case in experiments conducted by me over 75,000 nautical miles, and with no one to limit my expenditure of fuel.

It is important to bear in mind, when we are considering the value of Mr. Griffiths', propeller, that a mean average velocity of 8 or 9 knots an hour can readily be obtained by the combined action of steam and sail, and that the odds are always about three to one—except in opposing trade winds—that some canvas can be made to stand. But our present large screws militate sadly against a vessel's sailing qualities, when under sail alone, and prevent the carrying of after-canvas when under steam and sail.

I have mentioned a velocity of 8 or 9 knots, as that I imagine to be a good service speed for merchant vessels and men of war. With fast mail-boats going 12 or 13 knots an hour, the change of the direction of wind, would be too great to render canvas often available, unless going with the wind dead aft.

The economy of Mr. Griffiths' new propeller would be very great whilst running before a monsoon or trade wind, for when in its place, available at a moment's notice, under canvas alone, it would *not* retard the vessel's velocity in any material manner. Now the value of having steam in a ship, is the ability which it gives to keep up any determined average velocity, but if the sails will alone do this, we need not apply steam. We know that, in a run from Aden to Bombay, or from Point de Galle to Achen Head in the S.W. monsoon, the wind alone will drive a vessel at the rate of 8 or 9 knots an hour, even when only jury-rigged; and with the wind, a current of from 2 to 4 knots an hour is usually running, so that such vessel, if not impeded by her screw, may count on passing over the ground at the rate of 10 to 12 knots an hour.

As much science is required in the handling, as in the construction of steamers, and private companies and the Board of Admiralty are simply spending thousands a year unnecessarily when they neglect seriously to attend to these matters. I am one of those gentlemen who have been at issue with Mr. Reed on a very important point. He wished to lead you to imagine that a short ship can be made to go as fast as a long ship. If so, the whole Institution of Engineers, and the ship-builders are wrong in constructing ships, for they are going on increasing the length, and thus making a small power do an enormous amount of work. If Mr. Reed had confined himself to the advantage it is to a man-of-war to be short, for the facility of turning, that would have been another affair altogether; but we must not allow our minds to be diverted from the most important fact of the value of length. Mr. Griffiths has pointed out to you that as the length *increases*, the action of the screw upon it *decreases*. He has also pointed out that these long ships in the trough of the sea might be entirely at the mercy of the waves, a point in which I perfectly agree, and under those conditions, I think, as the length of ships, on the score of economy, must be increased, Mr. Griffiths is bringing forward a very clever invention to remedy the defect of the great additional length, or the one weak point of the increase of length that I have alluded to. He shows us also that instead of the one screw being 20 feet in diameter, you may have two of fourteen. Now I need not say, for mercantile ships as well as for men-of-war, what a great advantage it would be to be able to go up rivers with such a reduced draught of water.

We certainly are arriving at rather a dangerous point of length in our ships unless we have some new mode of propeller, as Mr. Griffiths proposes, at the extreme ends of the ship. There is an advantage, moreover, in having separate engines. In a ship like the "Devastation," with no masts at all, her safety lies in the number of engines she has got. They say there is no danger because there are two of them. I have taken the liberty to suggest that it is possible that the bearings may be affected by coal dust. In a run of 75,000 miles I never stopped

the ship but once, for injury to the engines, but I stopped her repeatedly, for the coal dust getting into the bearings and causing them to become heated. In the case of Mr. Griffiths's ship, if a heated bearing was to happen aft, it would not probably happen forward at the same time.

Captain WELLS, R.N.: The "Devastation" has four engines, a pair of engines to each screw.

Mr. GRIFFITHS: Another curious fact with regard to this vessel (the "Alpha") is, that when she is towing with the after-screw, going down the river, she pulls an enormous wave behind her, but when she is working with the forward screw, there is no wave at all; the water is quite smooth. In a boat going in the canal with only one screw, the suction of water is so great that she appears as if she was going up hill altogether.

Captain WELLS, R.N.: What suction is there by working the stern-screw?

Mr. GRIFFITHS: She sucks the water in by the screw. All the vessels in the canal go in this way, and the wave follows, whereas if you work by the bow-screw there is not the least difficulty of that kind. The fact is, we know very little about screw propelling; there are a great many things to be found out as to the effect of the resistance to bodies moving through water.

Captain WELLS: Might I ask what differences of speed you get in working singly either the bow or stern screws?

Mr. GRIFFITHS: As I have stated when we experimented with the model, when the two screws were working together we got 5·8; then when the stern-screw was worked without the tunnel, as a common screw, we got 4·62, and when it was worked in the tunnel 4·92. With the bow-screw alone we only got 4·2.

Captain WELLS: Then the difference is between 4·2 and 4·6. How do you turn her in her own length?

Mr. GRIFFITHS: I work one engine to throw the water out ahead, and the other to throw the water out astern.

Captain WELLS: You go ahead with one and astern with the other? Are you of opinion that if you were in the trough of the sea you would turn her in the same way?

Mr. GRIFFITHS: Yes.

Captain WELLS: With the two screws?

Mr. GRIFFITHS: One screw is quite enough to turn her in the trough of the sea.

Captain WELLS: In double screw-ships and in the "Waterwitch" it has been found to answer very well in still water, but directly you get into the trough of the sea, neither the one nor the other will do it.

Mr. GRIFFITHS: The "Waterwitch" has no leverage. The water coming out at the sides, all the leverage she has, is half the beam of the ship, while we have the leverage of the whole length of the ship.

Captain WELLS: As I understand it, the principal advantage of this system is small draught of water; the speed gained is not so very great.

Captain HOSEASON: Another advantage is that the momentum will be kept up, as both screws will never be out of the water at the same time; consequently there is no loss of momentum from the action of the screw ceasing altogether when the ship is pitching heavily.

Captain WELLS: Did you ever hear the results obtained in the American rivers by having the paddles in the centre of the ship?

Mr. GRIFFITHS: I saw that principle tried 30 years ago on the Seine. There were two boats, and the paddle in the middle. They do not go well. The friction, I imagine, is too great.

The CHAIRMAN: I beg to return your best thanks to Mr. Griffiths for his lecture and explanations.

PROPOSED METHOD OF ATTACK IN SKIRMISHING LINE.

By Captain F. G. S. Parker, 54th Regiment.

"The Prussians place the greatest importance upon the skilful conduct of *offensive* "fire-action."

. . . . . .

"For many years they have spared neither expense nor trouble in grounding "their whole infantry in every description of firing fighting."

. . . . . .

"In order to stimulate 'apell'" [*i.e.* disciplined *intelligent* obedience], "and enforce "discipline in firing, the assembly and expansion of small bodies in far more extended "fashion than the regulations at present prescribe must be practised, in addition to the "persevering performance of the regulations already contained in the instructions."*

Preliminary Remarks.

These remarks of Field-Marshal the Duke of Würtemberg, so exactly express the purposes I had in view in designing the following simple formation; they so accurately prescribe what our own infantry require to be taught, that I make no apology for quoting them as the text of this short paper.

All extended formations as yet introduced to notice, appear to me inapplicable to the *daily drill* of our Army. Our regiments are so weak when on the home establishment, that after deducting the requirements of detachments, guards, fatigues, &c., it is rarely (excepting during the periods such regiments are at the Curragh or Aldershot) that a sufficient number can be mustered for a really efficient parade on the present system of advancing by alternate half-battalions; or of skirmishing with the prescribed supports and reserves.

I need scarcely say more upon this, than that I have myself in Ireland seen a head-quarter parade, for many months, average four companies of single rank with only from sixteen to twenty *men* per company!

At Aldershot and the Curragh, where these drawbacks do not exist to such an extent, I have never found the men well in hand, skirmishing as at present laid down; the skirmishers get excited, and continually rush from one extreme to the other—they open out too much, and so lose the power of quick concentration, or they crowd too much (especially if cover be frequent) and so expose themselves to artillery fire. The line of a single company extended, is too great for the eye and voice of the Captain to control, more especially when a wind is blowing and firing going on; and the unity of action which is so

* "System of Attack of Prussian Infantry," by Lt. F.M. Duke of Würtemberg. Translated by Captain C. W. Robinson, R.B.

essential between the skirmishers, supports, and reserve, has to depend upon the intelligence of two or three Captains instead of on the judgment of one.

If it be said, that the system of skirmishing in double companies, and the general supervision of a Major counteracts these defects, I reply, 1stly, that the supervision of a mounted Officer ceases to be *promptly* effectual, directly the smoothness of a drill ground is exchanged for the ever-varying extent of broken, woody, or rolling country; and 2ndly, that men never work *very well* in double companies, for they only *hear* words of command from other than *their own company Officers*, and in extended formations it is of prime importance that the men should *recognise* the voice that orders them. On a regimental parade-ground, men obey the command of *any* Officer, provided his voice be powerful: but, during the excitement of a sham fight (and how much more so during an actual engagement) unless the *tone* be recognised, the order is apt to fall upon unheeding ears.

Proposed Formation.

The formation which I now submit to notice has these advantages:—

1. It can be as efficiently practised by a single company as by several; by a weak regiment as by a strong one; and by one or more regiments in brigade.

2. It habituates the men to work in the loosest as well as in the most compact order.

3. It teaches the company Officers to handle their men on an extended and ever-varying front. Each company is under the eye and complete control of its Captain, so that every advantage can be instantly secured, and every disadvantage can be rendered as nugatory as possible.

Battalion in Line.

A.

I have given the manœuvre from line only:—but it is obvious that it (C) can be assumed with equal facility from any column formation.

When within 1,600 yards,—or as much nearer the enemy as the nature of the country, &c., will allow, the Commanding Officer gives the order "*Advance in column of sections from right* [2nd, 3rd, or left sections] *of Companies.*"

Advance in Column of Sections from the Right of Companies.

B.

Hereupon 2nd, 3rd, and 4th sections make a half-right turn [or

respectively half right and left or half left] receiving "front turn" from the respective Section Commanders, and advance as B.

Upon arriving within the enemy's fire, the Battalion Commander [or Major, if advancing by half battalions] orders "*Leading sections, skirmish;*" upon which the Captain of Right Flank Company gives "Leading section from the left extend; inner sections half-right "turn;" at the same moment the Commander of *Rear* (4th) section halts his section.

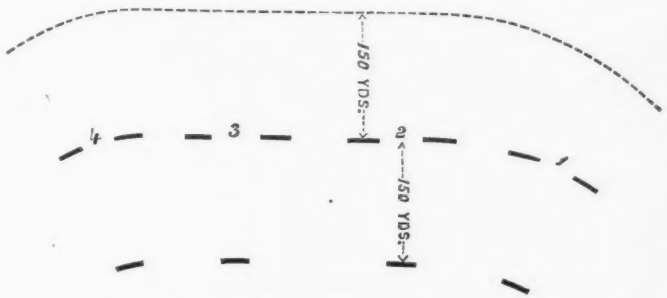
Simultaneously the Captains of the other companies perform the same manœuvre, but with this difference—the left flank company extends its leading section from the *right*, and its 2nd and 3rd sections make a half-left turn:—the leading sections of the other companies extend from their respective centres, and their inner sections receive the order "outwards half-turn."

The rear sections are halted by their respective Commanders same as the right flank rear section.

Second and third sections, when respectively in rear of centre of right and left, half of skirmishing section get from their section leaders "Front turn," and step short, or halt till the skirmishers are 150 yards a-head, when they continue the advance.

Half [or entire] Battalion advancing in a line of Company Columns.

C.



Position in the line of each Company-column on completion of the order "Leading sections—Skirmish."

The rear section of each company resumes its advance at 150 yards distance from, and covering the interval between 2nd and 3rd sections.

The two flank sections on receiving the order to extend incline to their outer flank, the left file in the one case, and the right file in the other, turning to the front, and commencing the extension when opposite the point that was the outer flank of the section before the extension.

It may, at first sight, appear a drawback that in this formation if the heads of the columns of sections (B) are the correct distance apart [*i.e.*, $\frac{8 \text{ number of files}}{10}$], there will be a skirmisher to every two (2)

paces on first extending,—but in an actual advance (other than a very short one on a barrack-square) such accuracy is impossible; and it is evident, and in the present case it is intended, that the respective company-columns open out to irregular distances from each other according to the nature of the ground,—so that in practice there will not be less than (3) three paces interval, which is a useful minimum; and when necessary, this distance can be readily increased.

Furthermore, against this possible objection, the following advantages are to be balanced.

a. Skirmishers can be re-inforced, relieved, overlapped from either flank, or the enemy misled by a refused flank of echeloned skirmishers, or sections.

b. If advisable so to do, line can be readily formed.

c. Groups and fours of skirmishers, and groups or section-squares, readily formed if threatened by cavalry.

d. The front can be readily extended or contracted.

e. A great depth [an important point in an army, which, like ours, must generally fight a defensive-offensive battle] obtained with a minimum exposure to artillery fire.

f. The *skirmisher-swarm* kept well in hand, since each section is under the eye of its leader, and each company well under the command of its Captain, whose *general* place will be with the two supporting sections until the whole are absorbed in the skirmishing line.

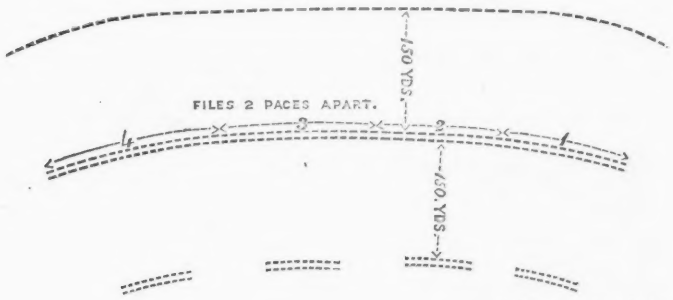
Note.

1. Whenever halted under fire, the three supporting sections should, as a general rule, lie down.

2. In advancing under fire, the three sections should march in loose order, *i.e.*, with about two paces interval between the files.

D.

Skirmishers in single rank 3 to 5 paces apart.



Second form of Manœuvre C, viz.:

Position of line of Company Columns when advancing under fire.

3. In this, and in every mode of extension, the rear rank man

should invariably be on the *left* of his front rank man when extended.

4. Skirmishers when recalled, should always clear the front and run in by the *nearest* flank. Thus in C, all the skirmishers, except those of the left flank company, would run in by the right flank.

5. Skirmishers should fire on the knee, or lying down, as occasion best serves; the present system of running to the front to fire is bad, as it "pumps" them, and endangers individuals in a long advance being shot by any men of less wind and speed, who must lag.

6. Individual skirmishers should be taught to rush forward only when they see good cover within a *reasonable* distance (say 25 yards as a maximum) the Section Commanders giving order if a longer rush has to be made.

7. For skirmishing and outpost duty, a whistle should be used to direct men when out of actual eyesight, or easy voice-range. There have been, for many years, whistles constructed whereon the whole of the bugle calls can be sounded; if this be thought too complicated an instrument for rough and ready use (though why should it be so considered?) any simpler kind might be adopted. In the campaign of 1866, the Prussian Officers provided themselves with common dog whistles and wore them attached by a piece of string, for these duties. The bugle is too loud for the secret and instantaneous direction of *skirmishing sections*.

N.B.—Since submitting the above to notice, I have been informed that a similar idea has been printed by General McDougall, and put into practice by the Austrians. Neither of these statements were known to me, nor to any of several *reading* Officers to whom I have shown my manœuvre: I therefore still think it advisable to bring it to notice in the pages of the "Royal United Service Journal," that discussion may be invited, and that my idea—if it prove really practical—may not lie useless.

NOTE ON ALIGNING THE SIGHTS OF ORDNANCE WHEN LAYING FOR AN OBJECT.

By Lieutenant H. H. Greenfell, R.N., H.M.S. "Excellent."

There are two different methods of aligning the sights of a gun on any object; in the Royal Navy, the captain of the gun aligns the sights from a position in rear of the gun slide, and at a considerable distance from the breech of the gun; while in the Royal Artillery, the alignment is obtained by placing the eye close to the hind-sight of the gun.

As this difference of method results in an actual difference in the laying of the gun, the "line of sight" and consequently the "line of fire," being always directed somewhat lower in the latter case than in the former, it may be as well to endeavour to discover the cause of this difference, and to show which system gives the nearest approach to a correct alignment.

The "nearest approach," because however great the powers of the eye, it exhibits certain defects as an optical instrument which preclude the possibility of perfect accuracy being obtained.

It is well known, for instance, that when several objects are at different distances in a direct line from the eye, a distinct image of only one of them can be received at the same instant—in other words, the eye can only be brought to a focus on one of them at a time—and that the other objects between and beyond, are actually doubled, and consequently appear hazy and indistinct.

Furthermore, when an object is brought close to the eye, this indistinctness and haziness are manifested in a greater degree, and when placed very close, the eye is incapable of receiving a definite image of the object, although fixed upon it.

We may conclude then—

That the more nearly different objects in a direct line from the eye lie close to one another, the more distinct will be the images of all of them produced upon the eye.

That the farther they lie apart in this line, or the more nearly any of them are approached to the eye, the greater will be the difficulty of obtaining a distinct image of all of them at one moment.

To apply these facts to our subject:

First let it be said that a regulation-sight is one where the line of sight is taken along a plane which bisects the depth of the notch in the hind-sight, touches the top of the fore-sight, and passes through the centre of the object; such an alignment being known as a "half" sight (Fig. 3).

Just, then, as the eye is placed close to the hind-sight does the difficulty of obtaining a clear and distinct image of this latter increase, and consequently that of estimating the point half way up its sloping

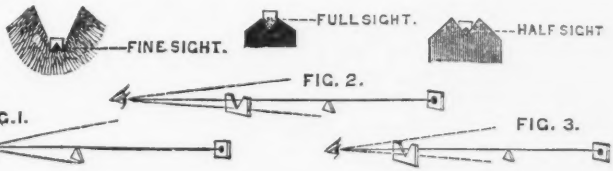
slides through which the line of sight should pass for a "half" or regulation-sight; hence the tendency is for the eye to seek and be guided by the easily distinguished *bottom* of the notch, with the result that what is known as a "fine" sight is taken, or the gun is laid *too low* (Fig. 1).

If, however, in order more clearly to see the hind-sight, the eye be removed to too great a distance in rear, then the fore-sight becomes indistinct, and the eye in order to be thoroughly sensible of it, is apt to bring it too far up into the alignment, and a "full" sight is the result, or the gun is laid *too high* (Fig. 2).

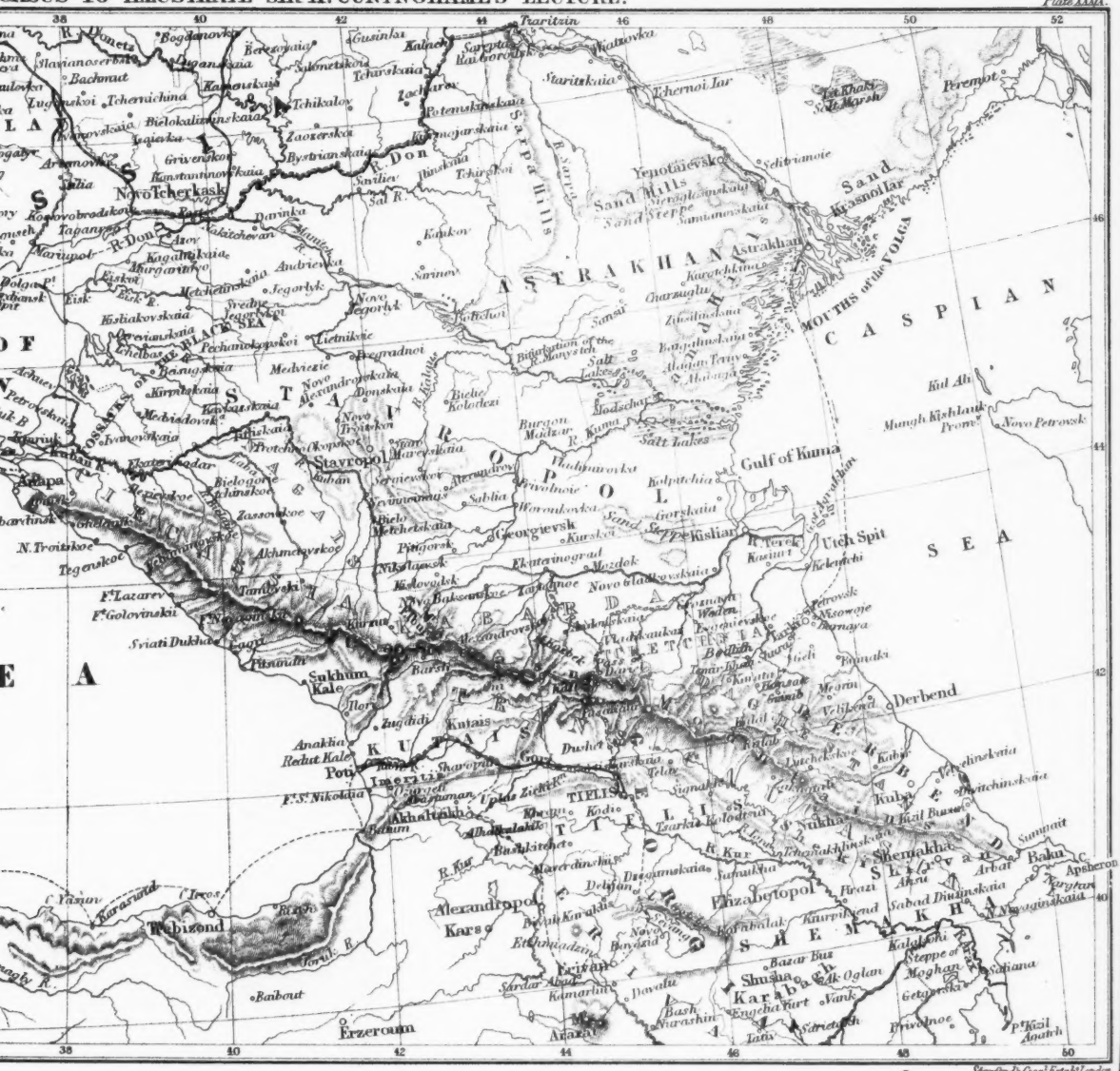
The proper position for the eye, which must vary with different powers of sight, but can be easily found by trial, would be at such a distance in rear, that the maximum distinctness is given to the hind-sight compatible with retaining a clear image of the fore-sight; then the "half" sight required can be more readily obtained (Fig. 3).

These conclusions, which can easily be verified by experiment, show, that the method in use in the Royal Navy is the more accurate of the two.

The practical difference is small, but where great accuracy at short ranges is desirable, as in testing armour-plates, &c., a knowledge of these facts may prove of value.



MAP OF THE BLACK SEA AND CAUCASUS TO


Tsaritzin
Kalach
Sarepta
Baiborodok
Volnovka
Staritzkaia
Tchernoi Iar
Ea Khaki
Salt Marsh
Perempt
Yenotaievsko
Sand Hills
Sand Steppe
Sand
Krasnoiar
Astrakhan
CASPIAN SEA
MOUTHS of the VOLGA
Kut Ali
Mungh Kishlauk
Point
Novo Petrovsk
Gulf of Kuma
Utch Spit
Kishlar
R. Terek
Kasumi
Kekrachi
Derbend
Petrovsk
Mitzowye
Barnaya
Bolshoi
Tarki
Bomaka
Megraa
Kubachinskaia
Kuba
Nukha
Shemakha
Baku
Apsheron
Sangaat
Akau
Arbat
Karytar
Vasyaginskaia
Elizabetopol
Hrazi
Sabad Diuzinskaia
Kurpinskaia
Kalakhan
Steppe of Meghan
Sabiana
Getapetska
Bazar Buz
Shusha
Karabagh
Ak Oglan
Vank
Engecha Kurt
Tatis
Pt Kasl Anatch
Kamarlu
Davalu
Bash Narashin
Sardar Abad
Erivan
Etchmiadzin
Novo Bayazid
Kars
Alexandropol
Delijan
Dusgunskaia
Tamalkha
Mavrodinskaia
Trebizond
Baibout
Erzeroum
Anara
Tiflis
Akhaltzikhe
Akhalkalaki
Batum
Redut Kale
Poti
Imeritia
Sharopan
Kutais
Dushet
Zugdidi
Sukhum Kale
Ilori
Anaklia
Tamboka
Lagri
Sviati Dukha
Fitsunda
F.t Lazarev
F.t Golovinski
N. Troitzkoe
Tegeriskoe
Akhmetzkoe
Stavropol
Georgievsk
Kursk
Mozdok
Kislovodsk
Nikolaievsk
Sablia
Pyatigorsk
Ekaterinogrod
Novo Blagodarnoe
Alexandrovsk
Vladikavkaz
Kolpatchia
Gorskaia
Sunja
Wasen
Kurinskaia
Kurinskoe
Novo Alexandrovskaia
Donskaia
Novo Troitzkoe
Medvezie
Pregradnoi
Novo Egorlsk
Egorlsk
Yegorlyk
Salt Lakes
Bogdanovka
Berezovaia
Tchervlenaia
Tchikalov
Zaozerskaia
Bystrianskaia
Grivenskoe
Konstantinovskaia
Novo Tcherkask
Rostov
Taganrog
Mariupol
Kagalnitzkaia
Kurgannitzko
Eiskaia
Yeisk
Kushakovskaia
Sredne Yegorlyk
Pechanokopskoi
Vietnikoe
Baranguskaia
Kirpitskaia
Kavkazskaia
Mekhedovsk
Ivanovskaia
Ekaterinodar
Ust Labinskoe
Labinskaia
Belogliniskoe
Zassovskoe
Akhtyrskoe
Tamanskaia
Kopskoe
Ivanovskaia
Pavlovskaia
Marevskaia
Uspenskaia
Sergievskoe
Alexandrovskoe
Voznesenskaia
Belo Kolodezi
Belo Metchetskaia
Burgun Maktar
Kuma
Vladimirovka
Volnoe
Warenkovska
Novo Tchervlenaia
Kuma
Kuban
Sea of Azof
Kuban
Labin